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MEDEK_2020\ANSYS\WBPZ\1s.wbpz

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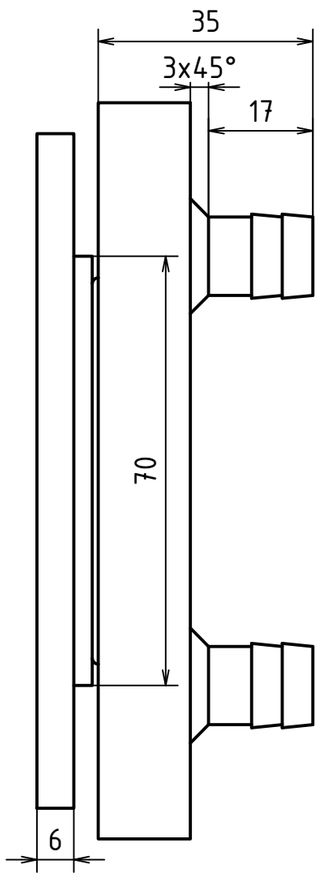
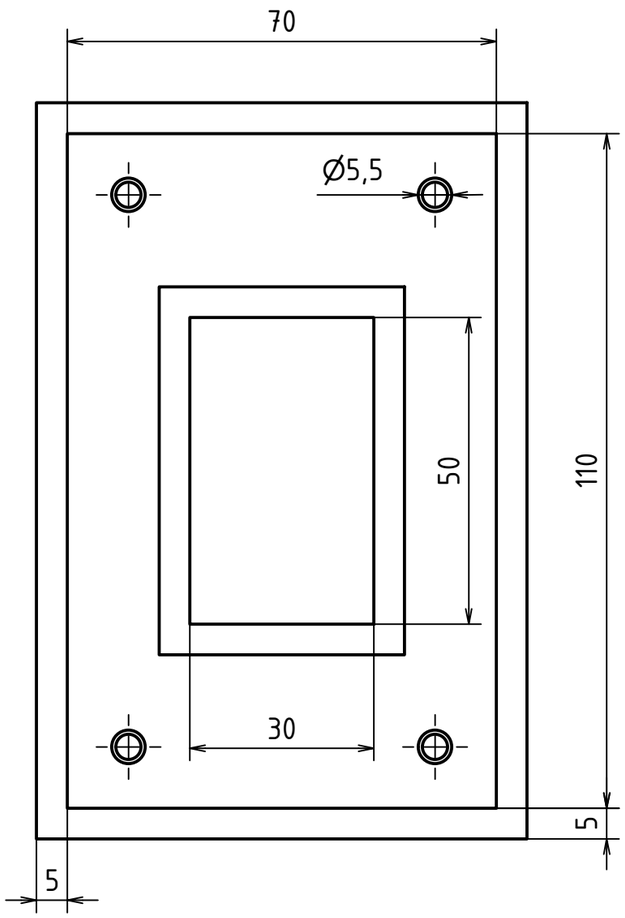
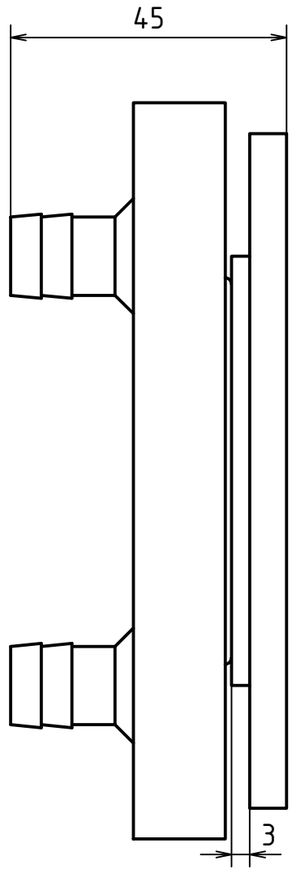
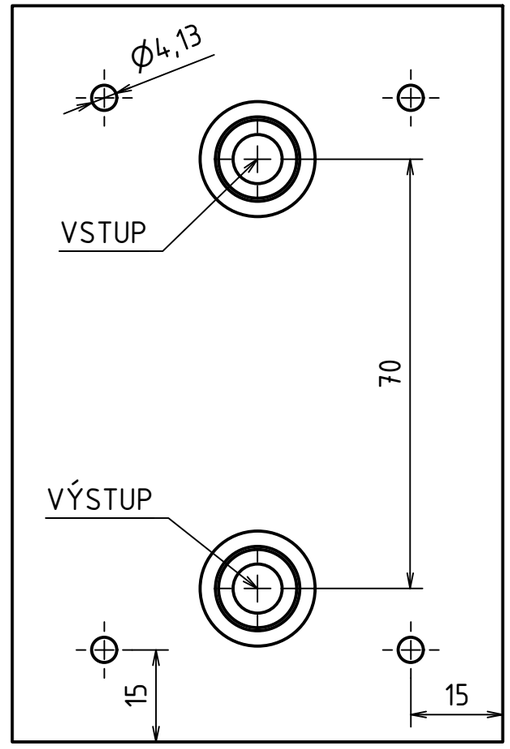
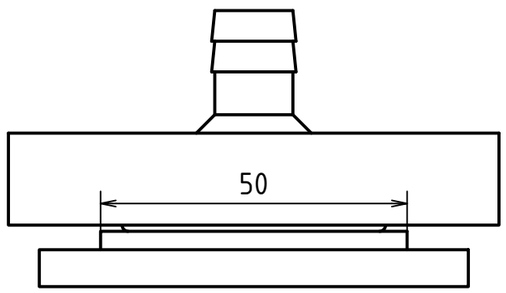
MEDEK_2020\ANSYS\VIZUALIZACE

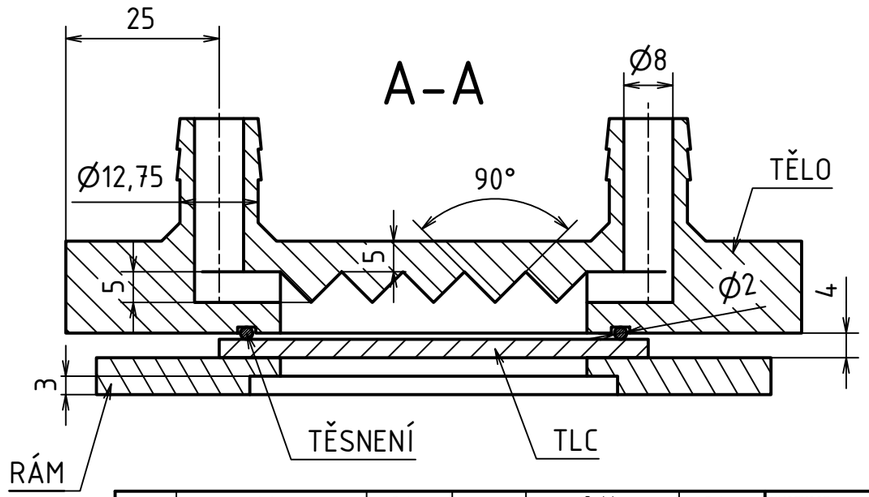


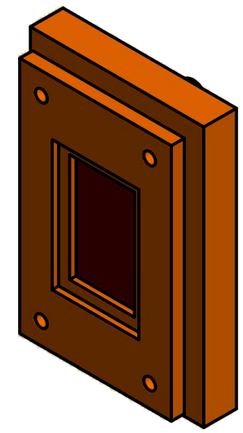












	Autor	Datum		Podpis	Datum	HMOTNOST	MĚŘÍTKO
NAVRHL	Jan Medek		PŘEZK.			SESTAVA	1 : 1
KRESLIL	Jan Medek		SCHVÁLIL			KUSOVNÍK	PROMÍTÁNÍ: (ISO E)

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

FAKULTA STROJNÍ

v5.0

NÁZEV: TLC KALIBRÁTOR 1

TYP:

ČÍSLO VÝKRESU: PŘÍLOHA 1

Příloha 2 – Návrh výpočtové sítě kalibrátoru 1

Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Model (A3)

Geometry

TABLE 2
Model (A3) > Geometry

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	C:\Users\Janme\Desktop\1_files\dp0\FFF\DM\FFF.agdb
Type	DesignModeler
Length Unit	Meters
Bounding Box	
Length X	3,e-002 m
Length Y	7,8e-002 m
Length Z	3,5e-002 m
Properties	
Volume	1,6096e-005 m³
Scale Factor Value	1,
Statistics	
Bodies	1
Active Bodies	1
Nodes	429014
Elements	1291862
Mesh Metric	None
Basic Geometry Options	
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	No
Compare Parts On Update	No
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\Janme\AppData\Local\Temp
Analysis Type	3-D
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	No

TABLE 3
Model (A3) > Geometry > Parts

Object Name	*INNER_BODY_3*
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	1
Definition	
Suppressed	No
Coordinate System	Default Coordinate System
Reference Frame	Lagrangian
Material	
Fluid/Solid	Defined By Geometry (Solid)
Bounding Box	
Length X	3,e-002 m
Length Y	7,8e-002 m
Length Z	3,5e-002 m
Properties	
Volume	1,6096e-005 m³
Centroid X	-3,7716e-019 m
Centroid Y	3,7202e-018 m
Centroid Z	7,3064e-003 m
Statistics	
Nodes	429014
Elements	1291862
Mesh Metric	None

Coordinate Systems

TABLE 4
Model (A3) > Coordinate Systems > Coordinate System

Object Name	*Global Coordinate System*
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0,
Origin	
Origin X	0, m
Origin Y	0, m
Origin Z	0, m
Directional Vectors	
X Axis Data	[1, 0, 0,]
Y Axis Data	[0, 1, 0,]
Z Axis Data	[0, 0, 1,]

Mesh

TABLE 5
Model (A3) > Mesh

Object Name	*Mesh*
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
Relevance	0
Sizing	
Use Advanced Size Function	On: Fixed
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Min Size	Default (1,3227e-005 m)
Max Face Size	Default (1,3227e-003 m)
Max Size	Default (2,6454e-003 m)
Growth Rate	Default (1,20)
Minimum Edge Length	5,e-003 m
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0,272
Maximum Layers	5
Growth Rate	1,2
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	
Method	None
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	Yes
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (1,1904e-005 m)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (6,6134e-006 m)
Statistics	
Nodes	429014
Elements	1291862
Mesh Metric	None

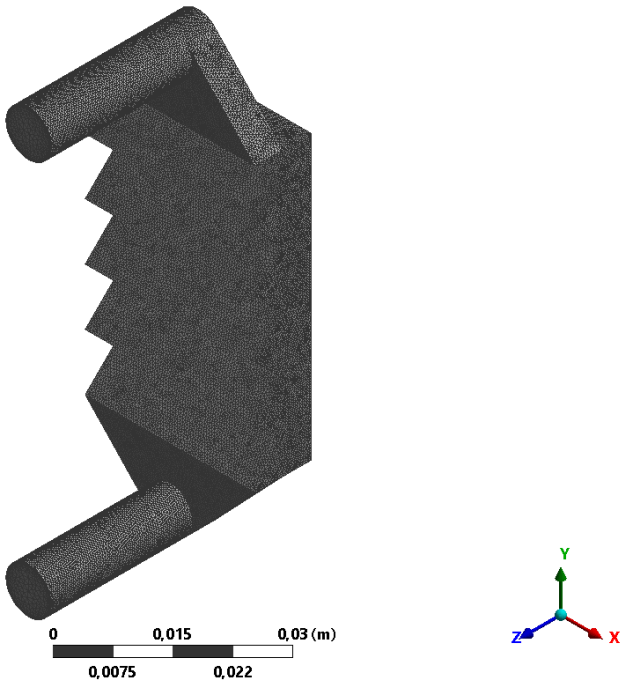
TABLE 6
Model (A3) > Mesh > Mesh Controls

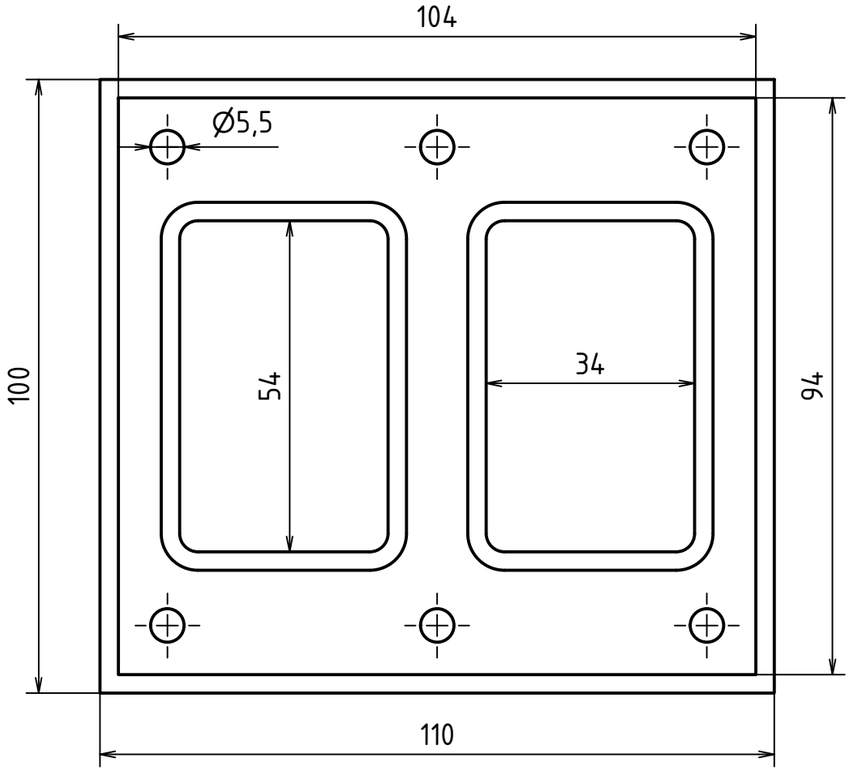
Object Name	*Inflation*	*Face Sizing*	*Face Sizing 2*
State	Fully Defined		
Scope			
Scoping Method	Geometry Selection	Named Selection	
Geometry	1 Body		
Named Selection		WALL	HEATFLUX
Definition			
Suppressed	No		
Boundary Scoping Method	Named Selections		
Boundary	Multiple Entities		
Inflation Option	First Layer Thickness		
First Layer Height	4,e-005 m		
Maximum Layers	6		
Growth Rate	1,2	Default	
Inflation Algorithm	Pre		
Type		Element Size	
Element Size		4,e-004 m	
Behavior		Soft	
Local Min Size		Default (1,3227e-005 m)	

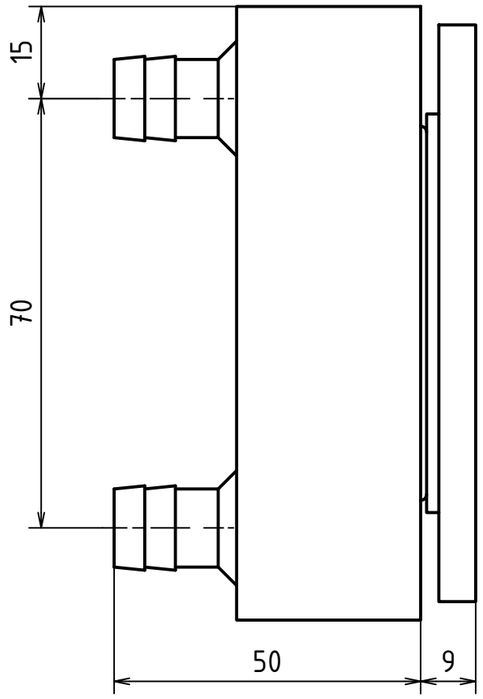
Named Selections

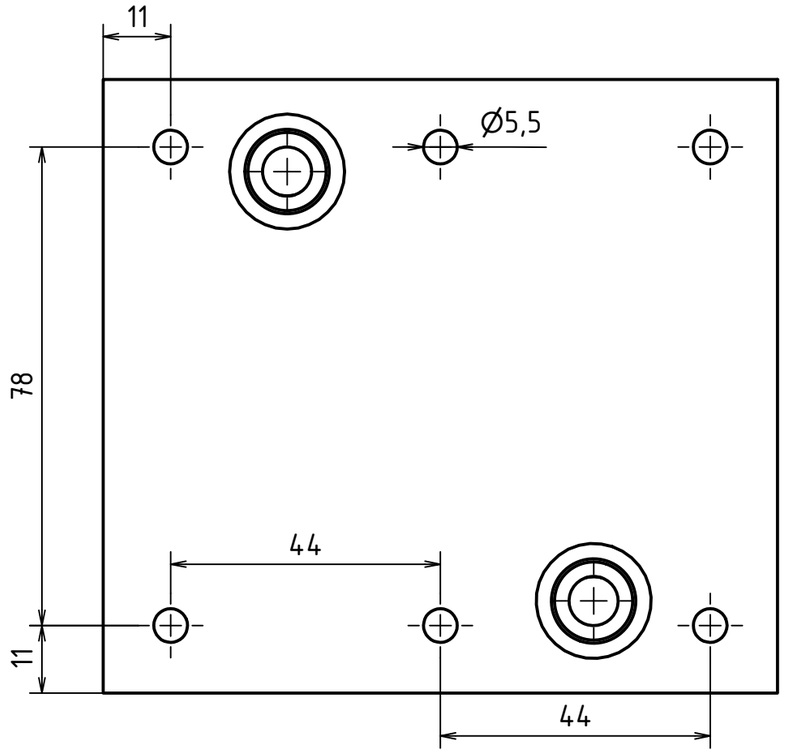
TABLE 7
Model (A3) > Named Selections > Named Selections

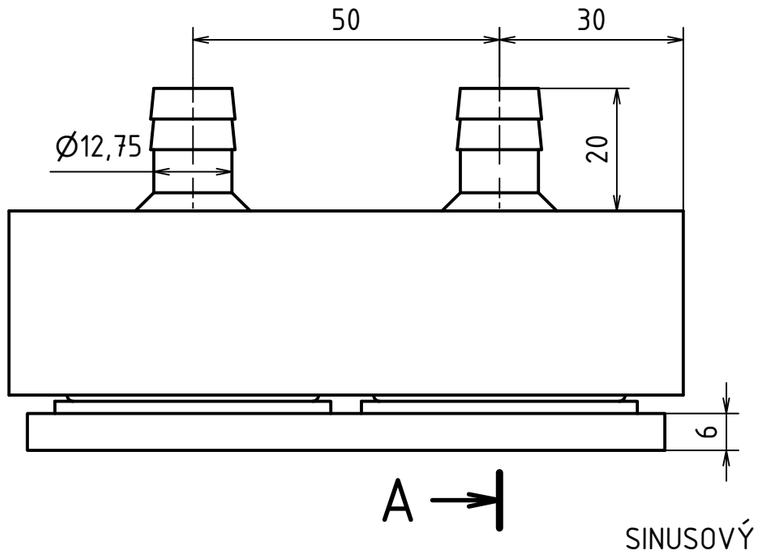
Object Name	*INLET*	*OUTLET*	*WALL*	*HEATFLUX*
State	Fully Defined			
Scope				
Scoping Method	Geometry Selection			
Geometry	1 Face	24 Faces		1 Face
Definition				
Send to Solver	Yes			
Visible	Yes			
Program Controlled Inflation	Exclude			
Statistics				
Type	Manual			
Total Selection	1 Face	24 Faces		1 Face
Suppressed	0			
Used by Mesh Worksheet	No			

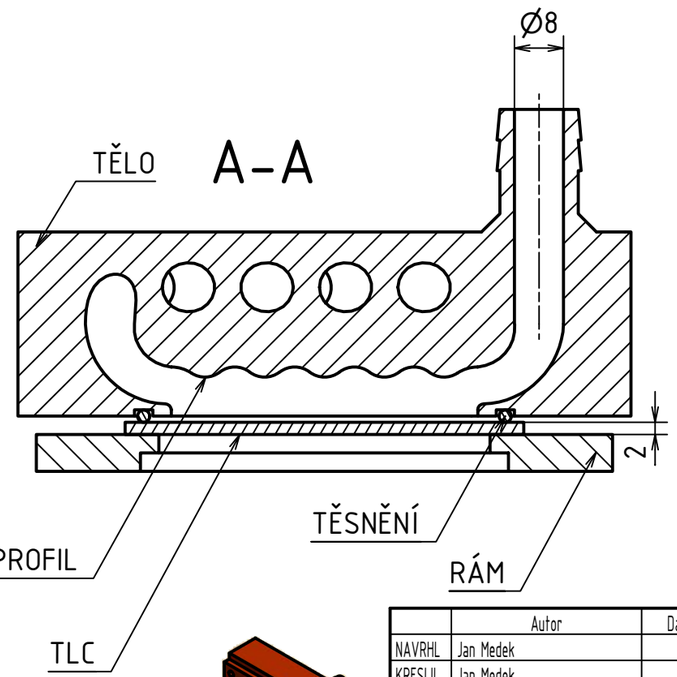


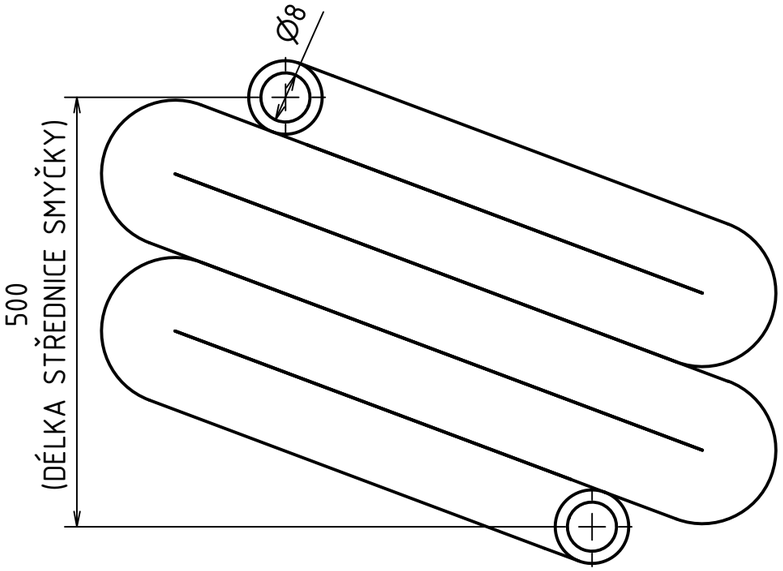


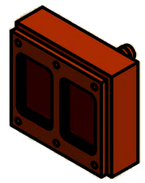












	Autor	Datum		Podpis	Datum	HMOTNOST	MĚŘÍTKO 1 : 1
NAVRHL	Jan Medek		PŘEZK.			SESTAVA	
KRESLIL	Jan Medek		SCHVÁLIL			KUSOVNÍK	PROMÍTÁNÍ: (ISO E)

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

FAKULTA STROJNÍ

v5.0

NÁZEV: TLC KALIBRÁTOR 2

TYP:

ČÍSLO VÝKRESU: PŘÍLOHA 3

Příloha 4 – Návrh výpočtové sítě kalibrátoru 2

Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Model (B3)

Geometry

TABLE 2
Model (B3) > Geometry

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	C:\Users\Janme\Desktop\2_files\dp0\Geom\DM\Geom.agdb
Type	DesignModeler
Length Unit	Meters
Bounding Box	
Length X	0,106 m
Length Y	7,8e-002 m
Length Z	5,e-002 m
Properties	
Volume	5,9912e-005 m³
Scale Factor Value	1,
Statistics	
Bodies	1
Active Bodies	1
Nodes	299397
Elements	877372
Mesh Metric	None
Basic Geometry Options	
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	No
Compare Parts On Update	No
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\Janme\AppData\Local\Temp
Analysis Type	3-D
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

TABLE 3
Model (B3) > Geometry > Parts

Object Name	*REV2_AS_3INNER_FILLET_STP_NEW_ORIGIN*
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	0,1
Definition	
Suppressed	No
Coordinate System	Default Coordinate System
Reference Frame	Lagrangian
Material	
Fluid/Solid	Defined By Geometry (Fluid)
Bounding Box	
Length X	0,106 m
Length Y	7,8e-002 m
Length Z	5,e-002 m
Properties	
Volume	5,9912e-005 m³
Centroid X	1,1724e-006 m
Centroid Y	-2,9286e-007 m
Centroid Z	-1,3121e-002 m
Statistics	
Nodes	299397
Elements	877372
Mesh Metric	None

Coordinate Systems

TABLE 4
Model (B3) > Coordinate Systems > Coordinate System

Object Name	*Global Coordinate System*
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0,
Origin	
Origin X	0, m
Origin Y	0, m
Origin Z	0, m
Directional Vectors	
X Axis Data	[1, 0, 0,]
Y Axis Data	[0, 1, 0,]
Z Axis Data	[0, 0, 1,]

Mesh

TABLE 5
Model (B3) > Mesh

Object Name	*Mesh*
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
Relevance	0
Sizing	
Use Advanced Size Function	On: Fixed
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Min Size	Default (2,0552e-005 m)
Max Face Size	Default (2,0552e-003 m)
Max Size	Default (4,1105e-003 m)
Growth Rate	Default (1,20)
Minimum Edge Length	6,4864e-007 m
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0,272
Maximum Layers	5
Growth Rate	1,2
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	
Method	None
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	No
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (1,8497e-005 m)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (1,0276e-005 m)
Statistics	
Nodes	299397
Elements	877372
Mesh Metric	None

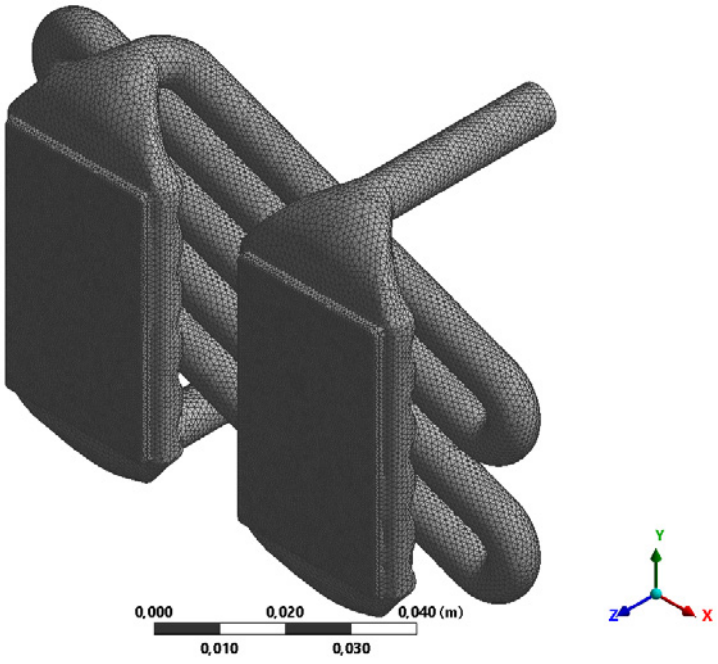
TABLE 6
Model (B3) > Mesh > Mesh Controls

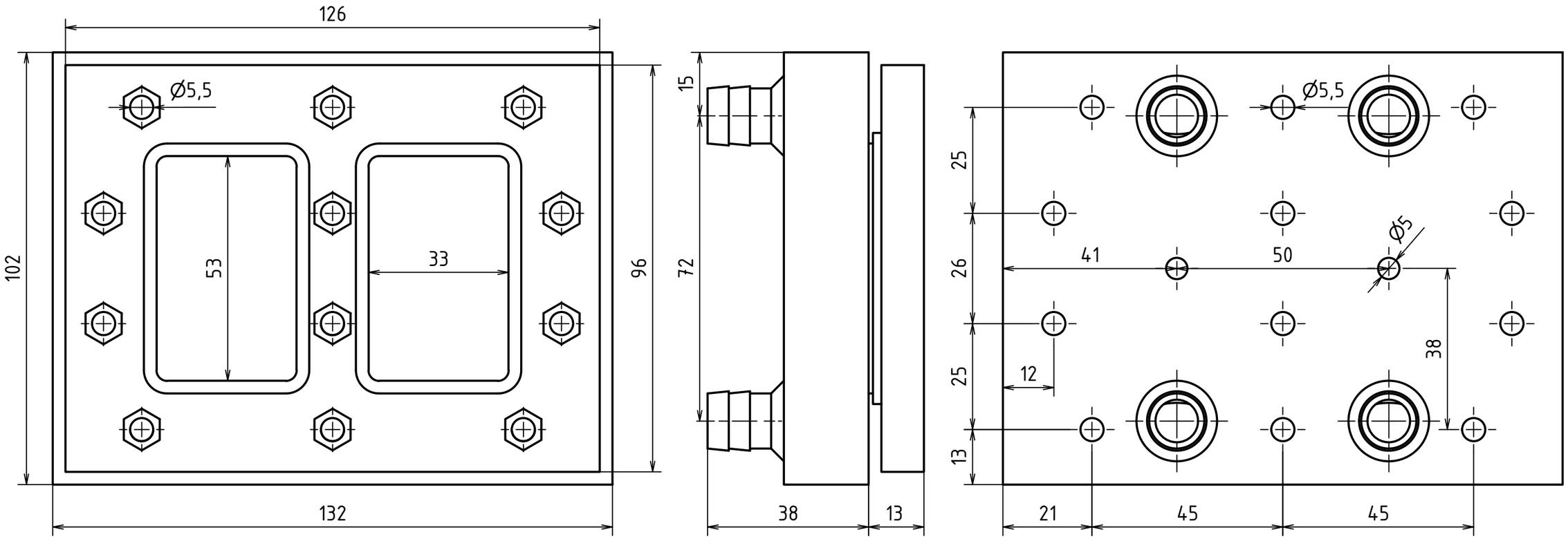
Object Name	*Inflation*	*Face Sizing*	*Face Sizing 2*
State	Fully Defined		
Scope			
Scoping Method	Geometry Selection		
Geometry	1 Body	328 Faces	2 Faces
Definition			
Suppressed	No		
Boundary Scoping Method	Geometry Selection		
Boundary	328 Faces		
Inflation Option	First Layer Thickness		
First Layer Height	1,e-004 m		
Maximum Layers	5		
Growth Rate	1,2	Default	
Inflation Algorithm	Pre		
Type		Element Size	
Element Size		1,e-003 m	5,e-004 m
Behavior		Soft	
Local Min Size		Default (2,0552e-005 m)	

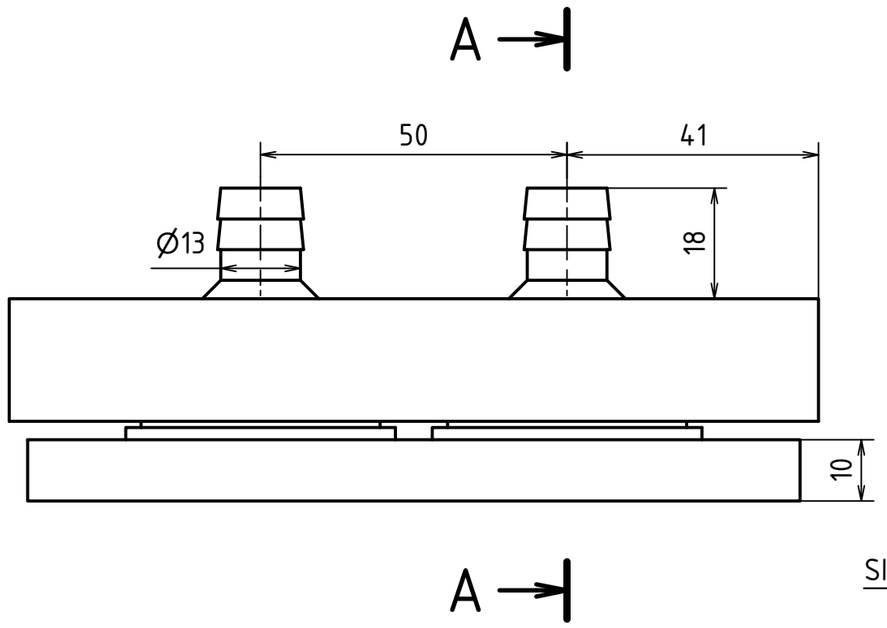
Named Selections

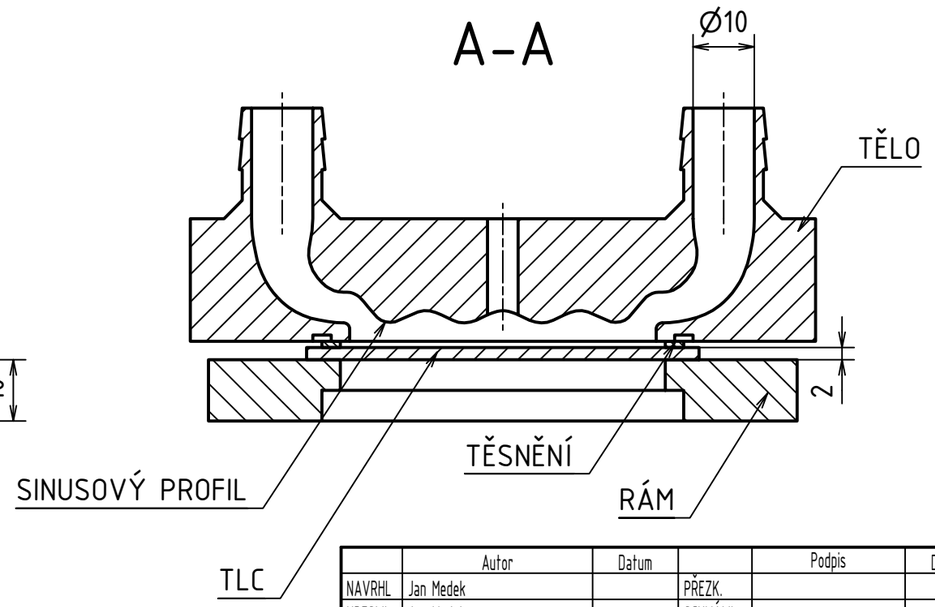
TABLE 7
Model (B3) > Named Selections > Named Selections

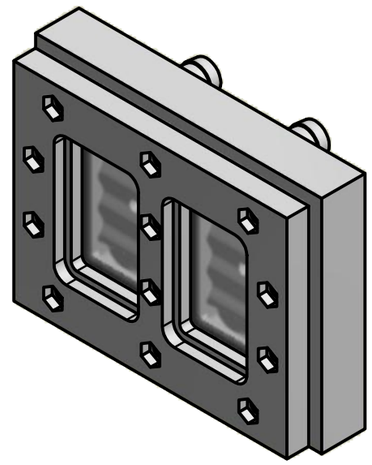
Object Name	*INLET*	*OUTLET*	*WALL*	*HEATFLUX*
State	Fully Defined			
Scope				
Scoping Method	Geometry Selection			
Geometry	1 Face		326 Faces	2 Faces
Definition				
Send to Solver	Yes			
Visible	Yes			
Program Controlled Inflation	Exclude			
Statistics				
Type	Manual			
Total Selection	1 Face		326 Faces	2 Faces
Suppressed	0			
Used by Mesh Worksheet	No			











	Autor	Datum		Podpis	Datum	HMOTNOST	MĚŘÍTKO
NAVRHL	Jan Medek		PŘEZK.			SESTAVA	1 : 1
KRESLIL	Jan Medek		SCHVÁLIL			KUSOVNÍK	PROMÍTÁNÍ: (ISO E)

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

FAKULTA STROJNÍ

v5.0

NÁZEV: TLC KALIBRÁTOR 3

TYP:

ČÍSLO VÝKRESU: PŘÍLOHA 5

Příloha 6 – Návrh výpočtové sítě kalibrátoru 3

Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Model (B3)

Geometry

TABLE 2
Model (B3) > Geometry

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	C:\Users\Janme\Desktop\3_files\dp0\Geom-1\DM\Geom-1.agdb
Type	DesignModeler
Length Unit	Meters
Bounding Box	
Length X	8,0001e-002 m
Length Y	8,5e-002 m
Length Z	0,1955 m
Properties	
Volume	7,8429e-005 m³
Scale Factor Value	1,
Statistics	
Bodies	1
Active Bodies	1
Nodes	293325
Elements	844311
Mesh Metric	None
Basic Geometry Options	
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	No
Compare Parts On Update	No
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\Janme\AppData\Local\Temp
Analysis Type	3-D
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

TABLE 3
Model (B3) > Geometry > Parts

Object Name	*FLUENT_SESTAVA_6pr_3real_int_smpl*
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	1
Definition	
Suppressed	No
Coordinate System	Default Coordinate System
Reference Frame	Lagrangian
Material	
Fluid/Solid	Defined By Geometry (Solid)
Bounding Box	
Length X	8,0001e-002 m
Length Y	8,5e-002 m
Length Z	0,1955 m
Properties	
Volume	7,8429e-005 m³
Centroid X	-1,1171e-005 m
Centroid Y	1,4805e-005 m
Centroid Z	-7,8287e-002 m
Statistics	
Nodes	293325
Elements	844311
Mesh Metric	None

Coordinate Systems

TABLE 4
Model (B3) > Coordinate Systems > Coordinate System

Object Name	*Global Coordinate System*
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0,
Origin	
Origin X	0, m
Origin Y	0, m
Origin Z	0, m
Directional Vectors	
X Axis Data	[1, 0, 0,]
Y Axis Data	[0, 1, 0,]
Z Axis Data	[0, 0, 1,]

Mesh

TABLE 5
Model (B3) > Mesh

Object Name	*Mesh*
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
Relevance	0
Sizing	
Use Advanced Size Function	On: Fixed
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Min Size	Default (3,324e-005 m)
Max Face Size	Default (3,324e-003 m)
Max Size	Default (6,6481e-003 m)
Growth Rate	Default (1,20)
Minimum Edge Length	5,735e-004 m
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0,272
Maximum Layers	5
Growth Rate	1,2
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	
Method	None
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	No
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (2,9916e-005 m)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (1,662e-005 m)
Statistics	
Nodes	293325
Elements	844311
Mesh Metric	None

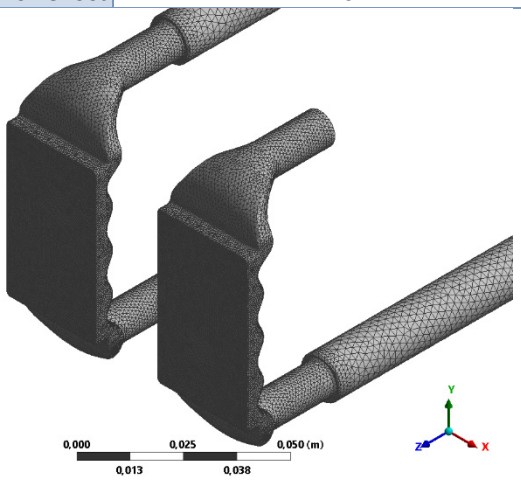
TABLE 6
Model (B3) > Mesh > Mesh Controls

Object Name	*Inflation*	*Face Sizing*	*Face Sizing 2*	*Face Sizing 3*	*Inflation 2*	*Inflation 3*	*Face Sizing 4*
State	Fully Defined						
Scope							
Scoping Method	Geometry Selection						
Geometry	1 Body	149 Faces	2 Faces	5 Faces	1 Body		124 Faces
Definition							
Suppressed	No						
Boundary Scoping Method	Geometry Selection				Geometry Selection		
Boundary	149 Faces				11 Faces	12 Faces	
Inflation Option	First Layer Thickness				First Layer Thickness		
First Layer Height	1,e-004 m				3,e-004 m	1,5e-004 m	
Maximum Layers	5				5		
Growth Rate	1,2	Default			1,2		Default
Inflation Algorithm	Pre				Pre		
Type		Element Size					Element Size
Element Size		1,e-003 m	5,e-004 m	2,e-003 m			6,e-004 m
Behavior		Soft					Soft
Local Min Size		Default (3,324e-005 m)					Default (3,324e-005 m)

Named Selections

TABLE 7
Model (B3) > Named Selections > Named Selections

Object Name	*INLET*	*OUTLET*	*WALL*	*HEATFLUX*
State	Fully Defined			
Scope				
Scoping Method	Geometry Selection			
Geometry	1 Face		147 Faces	2 Faces
Definition				
Send to Solver	Yes			
Visible	Yes			
Program Controlled Inflation	Exclude			
Statistics				
Type	Manual			
Total Selection	1 Face		147 Faces	2 Faces
Suppressed	0			
Used by Mesh Worksheet	No			



Příloha 7 – Skript pro vývojovou desku Arduino

```
// 1 x Arduino průtokoměr YF-S201 (yfs201) + 5 x Teplotní čidlo DS18B20 (DStemp)

// připojení knihoven pro teplotní čidlo DS18B20 (DStemp)
    #include <OneWire.h>
    #include <DallasTemperature.h>

// nastavení čísla vstupního ONE-WIRE pinu pro čidla teploty DS18B20 (DStemp)
    const int OneWireDStempPin = 3;

// vytvoření instance OneWireDS z knihovny OneWire
    OneWire OneWireDStemp(OneWireDStempPin);

// vytvoření instance DStemp z knihovny DallasTemperature
    DallasTemperature DStemp(&OneWireDStemp);

// nastavení čísel propojovacích pinů pro průtokoměr
    #define yfs201Pin 2
    #define InterruptPin 0 // 0 = digitální pin 2

// kalibrační podmínka YF-S201
// 7 pulzu za sekundu pro jednotku l/min
    const float CalibrFactor = 7;

// podmínky
    volatile byte PulseCount = 0;
    float yfs201 = 0.0;
    unsigned long OldTime = 0;
    unsigned long yfs201h = 0;

void setup() {
  // komunikace po sériové lince rychlostí 9600 baud
      Serial.begin(9600);

  // zapnutí komunikace knihovny s teplotním čidlem (DS18B20)
      DStemp.begin();

  // nastavení směru vstupního pinu (YF-S201)
      pinMode(yfs201Pin, INPUT);

  // nastavení vstupního pinu pro využití přerušení,
  // při detekci přerušení pomocí sestupné hrany (FALLING)
  // bude spuštěn podprogram PulsePlus
      attachInterrupt(InterruptPin, PulsePlus, FALLING);
}

void loop() {

  // načtení informací ze všech připojených čidel na daném pinu (teplomer)
      DStemp.requestTemperatures();

  // výpis teploty na sériovou linku, při připojení více čidel
  // na jeden pin můžeme postupně načíst všechny teploty
  // pomocí změny čísla v závorce (0) - pořadí dle unikátní adresy čidel

        Serial.println(" 5x DS18B20: ");

          Serial.print(" (1): ");
            Serial.print(DStemp.getTempCByIndex(0));
              Serial.print(" (°C) ");

          Serial.print(" (2): ");
            Serial.print(DStemp.getTempCByIndex(1));
              Serial.print(" (°C) ");

          Serial.print(" (3): ");
            Serial.print(DStemp.getTempCByIndex(2));
              Serial.print(" (°C) ");
```

```
          Serial.print(" (4): ");
            Serial.print(DStemp.getTempCByIndex(3));
              Serial.print(" (°C) ");

          Serial.print(" (5): ");
            Serial.print(DStemp.getTempCByIndex(4));

              Serial.println(" (°C) ");

  // pokud je rozdíl posledního uloženého času a aktuálního
  // 1 sekunda nebo více, provedeme měření
        if ((millis() - OldTime) > 1000) {

    // vypnutí detekce přerušení po dobu výpočtu a tisku výsledku
          detachInterrupt(InterruptPin);

    // výpočet průtoku podle počtu pulzů za daný čas v jednotkách l/min
    // se započtením kalibrační konstanty
          yfs201 = ((1000.0 / (millis() - OldTime)) * PulseCount) / CalibrFactor;

    // l/h
          yfs201h = yfs201 * 60;

    // vytištění všech dostupných informací po sériové lince

          Serial.println(" YF-S201: ");

            Serial.print(yfs201);
              Serial.print(" (l/min) ");

            Serial.print(yfs201h);
              Serial.println(" (l/h) ");

    // nulování počítadla pulzů
          PulseCount = 0;

    // uložení aktuálního času pro zahájení dalšího měření
          OldTime = millis();

    // povolení detekce přerušení pro nové měření
          attachInterrupt(InterruptPin, PulsePlus, FALLING);
}

  Serial.print("DATA,DATE,TIME,");
    Serial.print(DStemp.getTempCByIndex(0));
      Serial.print(",");
    Serial.print(DStemp.getTempCByIndex(1));
      Serial.print(",");
    Serial.print(DStemp.getTempCByIndex(2));
      Serial.print(",");
    Serial.print(DStemp.getTempCByIndex(3));
      Serial.print(",");
    Serial.print(DStemp.getTempCByIndex(4));
      Serial.print(",");
    Serial.print(yfs201);
      Serial.print(",");
        Serial.println(yfs201h);
}

// podprogram pro obsluhu přerušení
void PulsePlus() {

  // inkrementace čítače pulzů
          PulseCount++;
}
```

Příloha 8 - Matlab skript pro vyhodnocení dat z termokamery

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% IMPORT DATA %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

              close all; clear all; clc; format compact;
            TIM_MEAS_2 = importdata('TIM160_MERENI_2.txt');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% PARAMETERS %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

             t1 = 116;   %from (zoom time range)
             t2 = 128;   %to     (Measurement)

            t11 = 116;   %from (zoom time range)
            t12 = 122;   %to    (TRANSIENTS 1)

            t21 = 121;   %from (zoom time range)
            t22 = 127;   %to    (Transients 2)

         polynom = 3;     %polyfit order (find inflections)

            kL11 = 11600; %from (frame range)
            kL12 = 12200; %to (polyfit + find inflections)
            kP11 = 11600; %from
            kP12 = 12200; %to

            kL21 = 12100; %from (frame range)
            kL22 = 12700; %to (polyfit + find inflections)
            kP21 = 12100; %from
            kP22 = 12700; %to

%%%%%%%%%%%%%%%%%%%%%%%%%%%% WHOLE MEASUREMENT %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

           k = TIM_MEAS_2(:,1);
           t = TIM_MEAS_2(:,2);
         T_L = TIM_MEAS_2(:,3);
         T_P = TIM_MEAS_2(:,4);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(k,T_L,'r',k,T_P,'b');

       title('T vs k');
      legend('T_L vs k','T_P vs k','location','southeast');
      xlabel('k [Frame]');
      ylabel('T [°C]');
        axis([min(k) max(k) min(25) max(30)]);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(t,T_L,'r',t,T_P,'b',...
             [t1 t2],[26.5 26.5],'k',[t1 t1],[26.5 29.5],'k',...
             [t1 t2],[29.5 29.5],'k',[t2 t2],[26.5 29.5],'k');

       title('T vs t');
      legend('T_L vs t','T_P vs t','location','southeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t) max(t) min(25) max(30)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% ZOOM %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients','NumberTitle','off');

        plot(t,T_L,'r',t,T_P,'b');

       title('T vs t');
      legend('T_L vs t','T_P vs t','location','northeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t1) max(t2) min(26.5) max(29.5)]);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% TRANSIENTS 1 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients 1','NumberTitle','off');

         x1 = TIM_MEAS_2(kL11:kL12,2);
         y1 = TIM_MEAS_2(kL11:kL12,3);
         x2 = TIM_MEAS_2(kP11:kP12,2);
         y2 = TIM_MEAS_2(kP11:kP12,4);

[b1,S1,mu1] = polyfit(x1,y1,polynom);
        fy1 = polyval(b1,x1,S1,mu1);

[b2,S2,mu2] = polyfit(x2,y2,polynom);
        fy2 = polyval(b2,x2,S2,mu2);

        plot(t,T_L,'r',t,T_P,'b',x1,fy1,'k',x2,fy2,'k');

       title('T vs t');
      legend('T_L vs t','T_P vs t','T_L vs t (polyfit)',...
             'T_P vs t (polyfit)','location','southeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t11) max(t12) min(26.5) max(29.5)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% INFLECTIONS 1 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Inflections 1','NumberTitle','off');
      hold on;

        plot(t,T_L,'r',t,T_P,'b');

      d1fy1 = gradient(fy1,x1);
      d2fy1 = gradient(d1fy1,x1);
    t_infl1 = interp1(d1fy1,x1,max(d1fy1));
    y_infl1 = interp1(x1,fy1,t_infl1);
       slp1 = interp1(x1,d1fy1,t_infl1);
    intcpt1 = y_infl1-slp1*t_infl1;
      tngt1 = slp1*x1+intcpt1;

      d1fy2 = gradient(fy2,x2);
      d2fy2 = gradient(d1fy2,x2);
    t_infl2 = interp1(d1fy2,x2,max(d1fy2));
    y_infl2 = interp1(x2,fy2,t_infl2);
       slp2 = interp1(x2,d1fy2,t_infl2);
    intcpt2 = y_infl2-slp2*t_infl2;
      tngt2 = slp2*x2+intcpt2;

         T1 = t_infl1-t_infl2

        plot(x1,fy1,'-k',x2,fy2,'-k',x1,tngt1,'-k',x2,tngt2,'-k',...
             [t_infl1 t_infl2],[min(y2) min(y2)],'g',...
              t_infl1,y_infl1,'gp',t_infl2,y_infl2,'gp',...
             [t_infl1 t_infl1],[min(y2) y_infl1],'k',...
             [t_infl2 t_infl2],[min(y2) y_infl2],'k');

       title('T vs t');
      legend('T_L','T_P','T_L (polyfit)','T_P (polyfit)','tangent',...
             'tangent','delay','inflection points','Location','southeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t11) max(t12) min(26.5) max(29.5)]);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% TRANSIENTS 2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients 2','NumberTitle','off');

         x1 = TIM_MEAS_2(kL21:kL22,2);
         y1 = TIM_MEAS_2(kL21:kL22,3);
         x2 = TIM_MEAS_2(kP21:kP22,2);
         y2 = TIM_MEAS_2(kP21:kP22,4);

[b1,S1,mu1] = polyfit(x1,y1,polynom);
        fy1 = polyval(b1,x1,S1,mu1);

[b2,S2,mu2] = polyfit(x2,y2,polynom);
        fy2 = polyval(b2,x2,S2,mu2);

        plot(t,T_L,'r',t,T_P,'b',x1,fy1,'k',x2,fy2,'k');

       title('T vs t');
      legend('T_L vs t','T_P vs t','T_L vs t (polyfit)',...
             'T_P vs t (polyfit)','location','southwest');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t21) max(t22) min(26.5) max(29.5)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% INFLECTIONS 2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Inflections 2','NumberTitle','off');
      hold on;

        plot(t,T_L,'r',t,T_P,'b');

      d1fy1 = gradient(fy1,x1);
      d2fy1 = gradient(d1fy1,x1);
    t_infl1 = interp1(d1fy1,x1,min(d1fy1));
    y_infl1 = interp1(x1,fy1,t_infl1);
       slp1 = interp1(x1,d1fy1,t_infl1);
    intcpt1 = y_infl1-slp1*t_infl1;
      tngt1 = slp1*x1+intcpt1;

      d1fy2 = gradient(fy2,x2);
      d2fy2 = gradient(d1fy2,x2);
    t_infl2 = interp1(d1fy2,x2,min(d1fy2));
    y_infl2 = interp1(x2,fy2,t_infl2);
       slp2 = interp1(x2,d1fy2,t_infl2);
    intcpt2 = y_infl2-slp2*t_infl2;
      tngt2 = slp2*x2+intcpt2;

         T2 = t_infl1-t_infl2

        plot(x1,fy1,'-k',x2,fy2,'-k',x1,tngt1,'-k',x2,tngt2,'-k',...
             [t_infl1 t_infl2],[min(y2) min(y2)],'g',...
              t_infl1,y_infl1,'gp',t_infl2,y_infl2,'gp',...
             [t_infl1 t_infl1],[min(y2) y_infl1],'k',...
             [t_infl2 t_infl2],[min(y2) y_infl2],'k');

       title('T vs t');
      legend('T_L','T_P','T_L (polyfit)','T_P (polyfit)','tangent',...
             'tangent','delay','inflection points','Location','southwest');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t21) max(t22) min(26.5) max(29.5)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% END %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Příloha 9 - Matlab skript pro vyhodnocení odstínů HUE

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% IMPORT DATA %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

               close all; clear all; clc; format compact;
         TLC_HUE_MEAS_2 = importdata('TLC_HUE_MEAS_2_dataD360.txt');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% PARAMETERS %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

              t1 = 122;   %from (zoom time range)
              t2 = 132;   %to     (Measurement)

             t11 = 123;   %from (zoom time range)
             t12 = 125;   %to    (Transients 1)

             t21 = 128;   %from (zoom time range)
             t22 = 130;   %to    (Transients 2)

           order = 3;     %sgolayfit order (Savitzky-Golay filtering)
         framelen = 25;   %framelen

          polynom = 3;    %polyfit order (find inflections)

             kL11 = 14869; %from (frame range)
             kL12 = 14899; %to (polyfit + sgolayfit + find inflections)
             kP11 = 14816; %from
             kP12 = 14846; %to

             kL21 = 15539; %from (frame range)
             kL22 = 15569; %to (polyfit + sgolayfit + find inflections)
             kP21 = 15491; %from
             kP22 = 15521; %to

%%%%%%%%%%%%%%%%%%%%%%%%%%%% WHOLE MEASUREMENT %%%%%%%%%%%%%%%%%%%%%%%%%%%%%

           k = TLC_HUE_MEAS_2(:,1);
           t = TLC_HUE_MEAS_2(:,2);
       HUE_L = TLC_HUE_MEAS_2(:,3);
       HUE_P = TLC_HUE_MEAS_2(:,4);

   HUE_Lsgf = sgolayfilt(HUE_L,order,framelen);
   HUE_Psgf = sgolayfilt(HUE_P,order,framelen);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(k,HUE_L,'r',k,HUE_P,'b');

       title('HUE vs k');
      legend('HUE_L vs k','HUE_P vs k','location','northeast');
      xlabel('k [Frame]');
      ylabel('HUE [deg]');
        axis([min(k) max(k) min(0) max(360)]);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(t,HUE_L,'r',t,HUE_P,'b',...
             [t1 t2],[50 50],'k',[t1 t1],[50 300],'k',...
             [t1 t2],[300 300],'k',[t2 t2],[50 300],'k');

       title('HUE vs t');
      legend('HUE_L vs t','HUE_P vs t','location','northeast');
      xlabel('Time [s]');
      ylabel('HUE [deg]');
        axis([min(t) max(t) min(0) max(360)]);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% ZOOM %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients','NumberTitle','off');

        plot(t,HUE_L,'r',t,HUE_P,'b');

       title('HUE vs t');
      legend('HUE_L vs t','HUE_P vs t','location','northeast');
      xlabel('Time [s]');
      ylabel('HUE [deg]');
        axis([min(t1) max(t2) min(50) max(300)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% TRANSIENTS 1 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients 1','NumberTitle','off');

        plot(t,HUE_L,'r',t,HUE_P,'b',t,HUE_Lsgf,'k',t,HUE_Psgf,'k');

       title('HUE vs t');
      legend('HUE_L vs t','HUE_P vs t','HUE_L vs t (sgolayfit)',...
               'HUE_P vs t (sgolayfit)','location','southeast');
      xlabel('Time [s]');
      ylabel('HUE [deg]');
        axis([min(t11) max(t12) min(100) max(250)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% INFLECTIONS 1 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Inflections 1','NumberTitle','off');
      hold on;

        plot(t,HUE_L,'r',t,HUE_P,'b',t,HUE_Lsgf,'k',t,HUE_Psgf,'k');

         x1 = TLC_HUE_MEAS_2(kL11:kL12,2);
         y1 = TLC_HUE_MEAS_2(kL11:kL12,3);
         x2 = TLC_HUE_MEAS_2(kP11:kP12,2);
         y2 = TLC_HUE_MEAS_2(kP11:kP12,4);

      y1sgf = sgolayfilt(y1,order,framelen);
      y2sgf = sgolayfilt(y2,order,framelen);

[b1,S1,mu1] = polyfit(x1,y1sgf,polynom);
        fy1 = polyval(b1,x1,S1,mu1);
      d1fy1 = gradient(fy1,x1);
      d2fy1 = gradient(d1fy1,x1);
    t_infl1 = interp1(d1fy1,x1,max(d1fy1));
    y_infl1 = interp1(x1,fy1,t_infl1);
       slp1 = interp1(x1,d1fy1,t_infl1);
    intcpt1 = y_infl1-slp1*t_infl1;
      tngt1 = slp1*x1+intcpt1;

[b2,S2,mu2] = polyfit(x2,y2sgf,polynom);
        fy2 = polyval(b2,x2,S2,mu2);
      d1fy2 = gradient(fy2,x2);
      d2fy2 = gradient(d1fy2,x2);
    t_infl2 = interp1(d1fy2,x2,max(d1fy2));
    y_infl2 = interp1(x2,fy2,t_infl2);
       slp2 = interp1(x2,d1fy2,t_infl2);
    intcpt2 = y_infl2-slp2*t_infl2;
      tngt2 = slp2*x2+intcpt2;

         T1 = t_infl1-t_infl2

        plot(x1,fy1,'-g',x2,fy2,'-g',x1,tngt1,'-k',x2,tngt2,'-k',...
               [t_infl1 t_infl2],[(min(y2)-35) (min(y2)-35)],'g',...
                       t_infl1,y_infl1,'gp',t_infl2,y_infl2,'gp',...
                    [t_infl1 t_infl1],[(min(y2)-35) y_infl1],'k',...
                   [t_infl2 t_infl2],[(min(y2)-35) y_infl2],'k');

       title('HUE vs t');
      legend('HUE_L','HUE_P','HUE_L (sgolayfit)','HUE_P (sgolayfit)',...
             'HUE_L (polyfit)','HUE_P (polyfit)','tangent','tangent',...
```

```
                'delay','inflection points','Location','southeast');
      xlabel('Time [s]');
      ylabel('HUE [deg]');
        axis([min(t11) max(t12) min(100) max(250)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% TRANSIENTS 2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients 2','NumberTitle','off');

        plot(t,HUE_L,'r',t,HUE_P,'b',t,HUE_Lsgf,'k',t,HUE_Psgf,'k');

       title('HUE vs t');
      legend('HUE_L vs t','HUE_P vs t','HUE_L vs t (sgolayfit)',...
              'HUE_P vs t (sgolayfit)','location','southwest');
      xlabel('Time [s]');
      ylabel('HUE [deg]');
        axis([min(t21) max(t22) min(50) max(250)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% INFLECTIONS 2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Inflections 2','NumberTitle','off');
      hold on;

        plot(t,HUE_L,'r',t,HUE_P,'b',t,HUE_Lsgf,'k',t,HUE_Psgf,'k');

         x1 = TLC_HUE_MEAS_2(kL21:kL22,2);
         y1 = TLC_HUE_MEAS_2(kL21:kL22,3);
         x2 = TLC_HUE_MEAS_2(kP21:kP22,2);
         y2 = TLC_HUE_MEAS_2(kP21:kP22,4);

      y1sgf = sgolayfilt(y1,order,framelen);
      y2sgf = sgolayfilt(y2,order,framelen);

[b1,S1,mu1] = polyfit(x1,y1sgf,polynom);
        fy1 = polyval(b1,x1,S1,mu1);
      d1fy1 = gradient(fy1,x1);
      d2fy1 = gradient(d1fy1,x1);
    t_infl1 = interp1(d1fy1,x1,min(d1fy1));
    y_infl1 = interp1(x1,fy1,t_infl1);
       slp1 = interp1(x1,d1fy1,t_infl1);
    intcpt1 = y_infl1-slp1*t_infl1;
      tngt1 = slp1*x1+intcpt1;

[b2,S2,mu2] = polyfit(x2,y2sgf,polynom);
        fy2 = polyval(b2,x2,S2,mu2);
      d1fy2 = gradient(fy2,x2);
      d2fy2 = gradient(d1fy2,x2);
    t_infl2 = interp1(d1fy2,x2,min(d1fy2));
    y_infl2 = interp1(x2,fy2,t_infl2);
       slp2 = interp1(x2,d1fy2,t_infl2);
    intcpt2 = y_infl2-slp2*t_infl2;
      tngt2 = slp2*x2+intcpt2;

         T2 = t_infl1-t_infl2

        plot(x1,fy1,'-g',x2,fy2,'-g',x1,tngt1,'-k',x2,tngt2,'-k',...
             [t_infl1 t_infl2],[(min(y2)-115) (min(y2)-115)],'g',...
                      t_infl1,y_infl1,'gp',t_infl2,y_infl2,'gp',...
                   [t_infl1 t_infl1],[(min(y2)-115) y_infl1],'k',...
                  [t_infl2 t_infl2],[(min(y2)-115) y_infl2],'k');

       title('HUE vs t');
      legend('HUE_L','HUE_P','HUE_L (sgolayfit)','HUE_P (sgolayfit)',...
             'HUE_L (polyfit)','HUE_P (polyfit)','tangent','tangent',...
                'delay','inflection points','Location','southwest');
      xlabel('Time [s]');
      ylabel('HUE [deg]');
        axis([min(t21) max(t22) min(50) max(250)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% END %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Příloha 10

Matlab skript pro vyhodnocení dat z vývojové desky Arudino

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% IMPORT DATA %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

               close all; clear all; clc; format compact;
             ARD_MEAS_2 = importdata('ARDUINO_MERENI_2.txt');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% PARAMETERS %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

              t1 = 116;   %from (zoom time range)
              t2 = 128;   %to     (Measurement)

         Vst1mean = 8.259; %l/min

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% WHOLE MEASUREMENT %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

           k = ARD_MEAS_2(:,1);
           t = ARD_MEAS_2(:,2);
         T_L = ARD_MEAS_2(:,3);
         T_S = ARD_MEAS_2(:,4);
         T_P = ARD_MEAS_2(:,5);
         T_T = ARD_MEAS_2(:,6);
         T_O = ARD_MEAS_2(:,7);
        Vst1 = ARD_MEAS_2(:,8);
        Vst2 = ARD_MEAS_2(:,9);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(t,T_L,'r',t,T_P,'b',t,T_S,'b--',t,T_T,'r--',t,T_O,'k--');
       title('T vs t');
      legend('T_L vs t','T_P vs t','T_S vs t','T_T vs t','T_O vs t',...
                                              'location','southeast');
      xlabel('Time [s]');
      ylabel('Temperature [°C]');
        axis([min(t) max(t) min(min(T_S)-0.5) max(max(T_T)+0.5)]);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(t,Vst1,'k',[min(t) max(t)],[Vst1mean Vst1mean],'k--');
       title('Flow vs t');
      legend('Vst1 vs t','Vst1 mean vs t','location','southeast');
      xlabel('Time [s]');
      ylabel('Flow [l/min]');
        axis([min(t) max(t) min(Vst1mean-1) max(Vst1mean+1)]);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(t,T_L,'r',t,T_P,'b');
       title('T vs t');
      legend('T_L vs t','T_P vs t','location','southeast');
      xlabel('Time [s]');
      ylabel('Temperature [°C]');
        axis([min(t) max(t) min(min(T_P)-0.5) max(max(T_P)+0.5)]);

      figure('Name','Whole measurement','NumberTitle','off');

        plot(k,T_L,'r',k,T_P,'b');
       title('T vs k');
      legend('T_L vs k','T_P vs k','location','southeast');
      xlabel('k [Step]');
      ylabel('Temperature [°C]');
        axis([min(k) max(k) min(min(T_P)-0.5) max(max(T_P)+0.5)]);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% ZOOM %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Time range','NumberTitle','off');

        plot(t,T_L,'r',t,T_P,'b',t,T_S,'b--',t,T_T,'r--',t,T_O,'k--');
       title('T vs t');
      legend('T_L vs t','T_P vs t','T_S vs t','T_T vs t','T_O vs t',...
                                          'location','northeast');
      xlabel('Time [s]');
      ylabel('Temperature [°C]');
        axis([min(t1) max(t2) min(min(T_S)-0.5) max(max(T_T)+0.5)]);

      figure('Name','Time range','NumberTitle','off');

        plot(t,Vst1,'k',[min(t) max(t)],[Vst1mean Vst1mean],'k--');
       title('Flow vs t');
      legend('Vst1 vs t','Vst1 mean vs t','location','southeast');
      xlabel('Time [s]');
      ylabel('Flow [l/min]');
        axis([min(t1) max(t2) min(Vst1mean-1) max(Vst1mean+1)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% END %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Příloha 11

Matlab skript pro vyhodnocení dat z numerické simulace

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% IMPORT DATA %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

              close all; clear all; clc; format compact;
          ANS_NUM_3 = importdata('ANSYS_meas_2_1150_1_EDIT.txt');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% PARAMETERS %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

             %1°C = 1K,
               C0 = 273.15; %K

              t11 = 1.4;   %from (zoom time range)
              t12 = 2.4;   %to    (TRANSIENTS 1)

              t21 = 6.4;   %from (zoom time range)
              t22 = 7.4;   %to    (TRANSIENTS 2)

           polynom = 3;     %polyfit order (find inflections)

              kL11 = 190;   %from (step range)
              kL12 = 210;   %to (polyfit + find inflections)
              kP11 = 151;   %from
              kP12 = 159;   %to

              kL21 = 690;   %from (step range)
              kL22 = 710;   %to (polyfit + find inflections)
              kP21 = 651;   %from
              kP22 = 659;   %to

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% WHOLE MEASUREMENT %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

            k =  ANS_NUM_3(:,1);
            t =  ANS_NUM_3(:,2);
         T_IN = (ANS_NUM_3(:,3)-C0);
          T_L = (ANS_NUM_3(:,4)-C0);
          T_P = (ANS_NUM_3(:,5)-C0);

       figure('Name','Whole measurement','NumberTitle','off');

         plot(k,T_IN,'k',k,T_L,'r',k,T_P,'b');

        title('T vs k');
       legend('T_I vs k','T_L vs k','T_P vs k','location','northeast');
       xlabel('k [Step]');
       ylabel('T [°C]');
         axis([min(k) max(k) min(min(T_IN)-1) max(max(T_IN)+1)]);

       figure('Name','Whole measurement','NumberTitle','off');

         plot(t,T_IN,'k',t,T_L,'r',t,T_P,'b');

        title('T vs t');
       legend('T_I vs t','T_L vs t','T_P vs t','location','northeast');
       xlabel('Time [s]');
       ylabel('T [°C]');
         axis([min(t) max(t) min(min(T_IN)-1) max(max(T_IN)+1)]);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% TRANSIENTS 1 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients 1','NumberTitle','off');

         x1 =  ANS_NUM_3(kL11:kL12,2);
         y1 = (ANS_NUM_3(kL11:kL12,4)-C0);
         x2 =  ANS_NUM_3(kP11:kP12,2);
         y2 = (ANS_NUM_3(kP11:kP12,5)-C0);

[b1,S1,mu1] = polyfit(x1,y1,polynom);
        fy1 = polyval(b1,x1,S1,mu1);

[b2,S2,mu2] = polyfit(x2,y2,polynom);
        fy2 = polyval(b2,x2,S2,mu2);

        plot(t,T_L,'r',t,T_P,'b',x1,fy1,'k',x2,fy2,'k');

       title('T vs t');
      legend('T_L vs t','T_P vs t','T_L vs t (polyfit)',...
             'T_P vs t (polyfit)','location','southeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t11) max(t12) min(min(T_IN)-2) max(max(T_IN)+1)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% INFLECTIONS 1 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Inflections 1','NumberTitle','off');
      hold on;

        plot(t,T_L,'r',t,T_P,'b');

      d1fy1 = gradient(fy1,x1);
      d2fy1 = gradient(d1fy1,x1);
    t_infl1 = interp1(d1fy1,x1,max(d1fy1));
    y_infl1 = interp1(x1,fy1,t_infl1);
       slp1 = interp1(x1,d1fy1,t_infl1);
    intcpt1 = y_infl1-slp1*t_infl1;
      tngt1 = slp1*x1+intcpt1;

      d1fy2 = gradient(fy2,x2);
      d2fy2 = gradient(d1fy2,x2);
    t_infl2 = interp1(d1fy2,x2,max(d1fy2));
    y_infl2 = interp1(x2,fy2,t_infl2);
       slp2 = interp1(x2,d1fy2,t_infl2);
    intcpt2 = y_infl2-slp2*t_infl2;
      tngt2 = slp2*x2+intcpt2;

         T1 = t_infl1-t_infl2

        plot(x1,fy1,'-k',x2,fy2,'-k',x1,tngt1,'-k',x2,tngt2,'-k',...
                 [t_infl1 t_infl2],[min(T_IN)-1 min(T_IN)-1],'g',...
                       t_infl1,y_infl1,'gp',t_infl2,y_infl2,'gp',...
                    [t_infl1 t_infl1],[min(T_IN)-1 y_infl1],'k',...
                   [t_infl2 t_infl2],[min(T_IN)-1 y_infl2],'k');

       title('T vs t');
      legend('T_L','T_P','T_L (polyfit)','T_P (polyfit)','tangent',...
             'tangent','delay','inflection points','Location','southeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t11) max(t12) min(min(T_IN)-2) max(max(T_IN)+1)]);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% TRANSIENTS 2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Transients 2','NumberTitle','off');

         x1 =  ANS_NUM_3(kL21:kL22,2);
         y1 = (ANS_NUM_3(kL21:kL22,4)-C0);
         x2 =  ANS_NUM_3(kP21:kP22,2);
         y2 = (ANS_NUM_3(kP21:kP22,5)-C0);

[b1,S1,mu1] = polyfit(x1,y1,polynom);
        fy1 = polyval(b1,x1,S1,mu1);

[b2,S2,mu2] = polyfit(x2,y2,polynom);
        fy2 = polyval(b2,x2,S2,mu2);

        plot(t,T_L,'r',t,T_P,'b',x1,fy1,'k',x2,fy2,'k');

       title('T vs t');
      legend('T_L vs t','T_P vs t','T_L vs t (polyfit)',...
             'T_P vs t (polyfit)','location','northeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t21) max(t22) min(min(T_IN)-2) max(max(T_IN)+1)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% INFLECTIONS 2 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      figure('Name','Inflections 2','NumberTitle','off');
      hold on;

        plot(t,T_L,'r',t,T_P,'b');

      d1fy1 = gradient(fy1,x1);
      d2fy1 = gradient(d1fy1,x1);
    t_infl1 = interp1(d1fy1,x1,min(d1fy1));
    y_infl1 = interp1(x1,fy1,t_infl1);
       slp1 = interp1(x1,d1fy1,t_infl1);
    intcpt1 = y_infl1-slp1*t_infl1;
      tngt1 = slp1*x1+intcpt1;

      d1fy2 = gradient(fy2,x2);
      d2fy2 = gradient(d1fy2,x2);
    t_infl2 = interp1(d1fy2,x2,min(d1fy2));
    y_infl2 = interp1(x2,fy2,t_infl2);
       slp2 = interp1(x2,d1fy2,t_infl2);
    intcpt2 = y_infl2-slp2*t_infl2;
      tngt2 = slp2*x2+intcpt2;

         T2 = t_infl1-t_infl2

        plot(x1,fy1,'-k',x2,fy2,'-k',x1,tngt1,'-k',x2,tngt2,'-k',...
                 [t_infl1 t_infl2],[min(T_IN)-1 min(T_IN)-1],'g',...
                       t_infl1,y_infl1,'gp',t_infl2,y_infl2,'gp',...
                    [t_infl1 t_infl1],[min(T_IN)-1 y_infl1],'k',...
                   [t_infl2 t_infl2],[min(T_IN)-1 y_infl2],'k');

       title('T vs t');
      legend('T_L','T_P','T_L (polyfit)','T_P (polyfit)','tangent',...
             'tangent','delay','inflection points','Location','northeast');
      xlabel('Time [s]');
      ylabel('T [°C]');
        axis([min(t21) max(t22) min(min(T_IN)-2) max(max(T_IN)+1)]);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% END %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```