Article

3D-Druck in der Verfahrenstechnik, Final Project AMIR

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1. Introduction

Additive Manufacturing, AM, is in fact not a new concept. It can track back to 150 years ago, when people used two-dimensional layer overlays to form three-dimensional topographic maps. During the 1960s and 1970s came the first AM-Technology, include photopolymerization technology, Powder fusion in 1972 and sheet lamination in 1979. But at that time, it has no commercial market at all and very few investment in research and development. [1] The first 3D printer, which used the stereolithography technique, was created by Charles W. Hull in the mid-1980s. [2]

After 30 years development, 3D Printng has come into personal home. The price is nowadays down to 300 dollars.3D Printing, as a bottom-up-process, has many advantages. With 3D printing, designers have the ability to quickly turn concepts into 3D models or prototypes, and implement rapid design changes. It makes development so much easier, quicker and cheaper.

Generally, development steps look like this:

1. Identification of project requirements
2. Computer-aided 3D Model design
3. Simulation of the 3D Model in corresponding physical field
4. Optimize according to the results from Simulation
5. Print real 3D Model via 3D Printing and do experiment
6. Optimize according to the results from experiment

In this project we will show you how to combine Computer-aided 3D Printing technologies with simulation and data processing to achieve our goal.

2. Problem

In our project we have a pipe (Material: Polymer) up to 300mm long, with a internal diameter of 94 mm. A static heat-exchanger need to be built inner the pipe, so that 10 °C water flow from one side and left the other side 80 °C± 5 °C the temperature distribution should be evenly along radial direction. Fluid volume is given with 0.5 m^3/h. As thermal source we have chosen electromagnetic induction. To check the temperature along the pipe, we have chosen an infrared thermometer. And another important parameter that need to be confirmed in the experiment is the press-drop.

Material ??? (not be defined)

3. Solution

3.1. CAD-Model

3D Model is made by Openscad, an open-resource CAD program.

3.2. Computational Fluid Dynamics(CFD) simulation with Siemens Star-CCM+

Simulation is a powerful tool to check the quality of the designed system and help to optimize the model and the process.

Here in our project it is about Computational fluid dynamics simulation that combines fluid with solid.

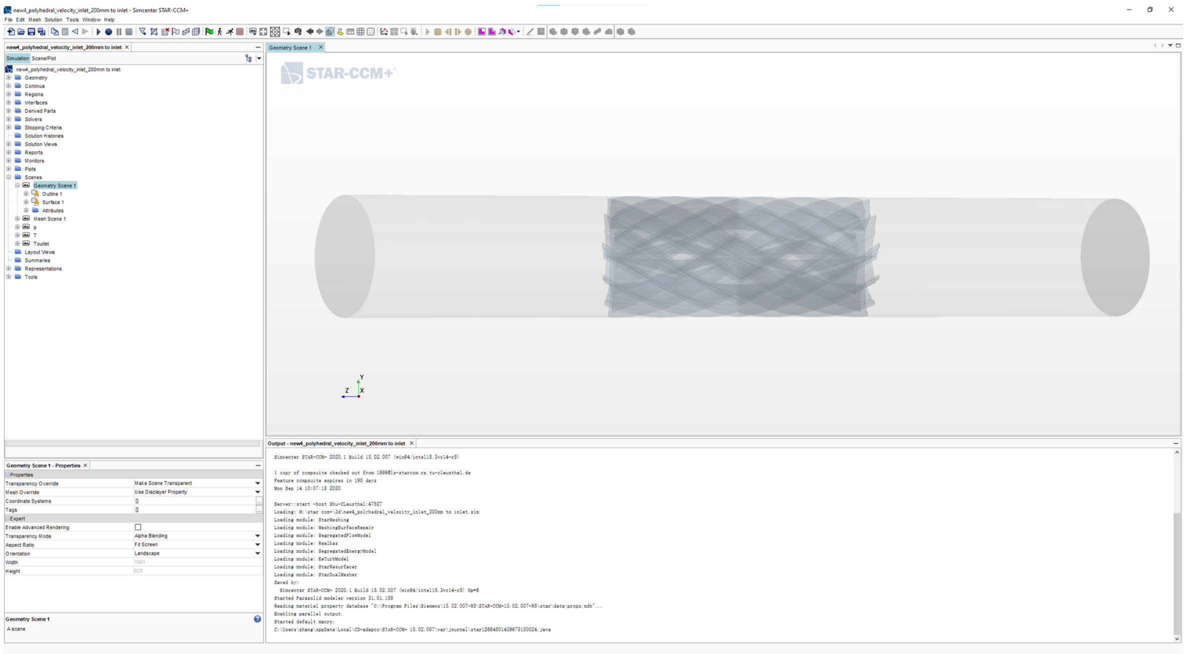

Figure 1. Below is a sketch of our simulation.

Static heat-exchanger is in the middle.

Now we go further into details.

4. Conclusions

Author Contributions:

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Conflicts of Interest:

Abbreviations

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of open access journals
TLA	Three letter acronym
LD	linear dichroism

Appendix A. Requirement Specification

Table A1. Requirement specification list for the heat exchanger

Obligatory or Desirable	Category	Description	Value	Person Responsible	Last Changed
Obligatory	Performance	volume flow rate	greater 0.5 m^3/h	Scherf	2020-06-23
Obligatory	Performance	heat distribution	radial and evenly	Scherf	2020-06-23
Obligatory	Performance	heating water flowing trough	from 10 °C to 80 °C	Scherf	2020-06-23
Obligatory	Performance	low pressure drop		Scherf	2020-06-23
Obligatory	Material	material temperature resistance	between 0 °C and 90 °C	Group A	2020-06-23
Obligatory	Material	material water solvability	unsolvable in water	Group A	2020-06-23
Obligatory	Material	electrical conductivity	greater 10^6 S/m	Group A	2020-06-23
Obligatory	Manufacturing	manufacturing process	additive manufacturing	Scherf	2020-06-23
Desirable	Geometry	customizability of model	model is parameterized	Group A	2020-06-23
Obligatory	Geometry	outer Shape	cylindrical	Group A	2020-06-23
Obligatory	Geometry	outer diameter	94 mm	Scherf	2020-06-23
Desirable	Geometry	length	up to 300 mm	Scherf	2020-06-23
~~Obligatory~~	~~Geometry~~	~~outer wall~~	~~closed~~		2020-06-23
~~Desirable~~	~~Geometry~~	~~outer wall thickness~~	~~smaller 5 mm~~		2020-06-23
Obligatory	Geometry	water flow direction	fixed direction	Scherf	2020-06-23

Appendix B. Simulation Model Requirement Specification

Table A2. Requirement specification list for the heat exchanger simulation model

Obligatory or Desirable	Category	Description	Value	Person Responsible
Desirable	Input	file type	STL	Group A
Obligatory	Input	fit within L=300 mm, D=94 mm cylinder		Group A
Obligatory	Input	material	?	Group A
Obligatory	Simulation Geometry	tube	L=500 mm, D=94 mm cylinder	Group A
Obligatory	Simulation Geometry	inlet Velocity	See Table A.1	Group A
Obligatory	Simulation Geometry	wall type	adiabatic	Group A
Obligatory	Output Values	pressure value at outlet	outlet pressure	Group A
Obligatory	Output Pictures	cut along the length and center of the cylinder showing velocity		Group A
Obligatory	Output Pictures	cut along the length and center of the cylinder showing temperature		Group A
Obligatory	Output Pictures	at outlet showing temperature		Group A

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