Errata List

“Release of High-Pressure Hydrogen into the Air” Master’s Thesis

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October 1st, 2021

This is a list of typographical and linguistic corrections for the master’s thesis “Release of High-Pressure Hydrogen into the Air”. Only significant changes in the first edition are included in this list.

The final edition of this master’s thesis as well as the other relevant materials can be fined under this access link: https://github.com/Keivan-A-Gh/Master_Thesis

page	Para.	Line	Original Text	Corrected Text
1	Title		Release of high-pressure hydrogen into the air	Release of High-Pressure Hydrogen into the Air
2	Number of Pages		118	120
3*	Task Description			Adding task description of the first semester, in addition to the previous one.
4	1	6	250 MPa	25 MPa
6-7	Table of Contents			Updating the entire table of content based on the new paging
9-10	Headers		1 Introduction	Nomenclature
25	1	2	… Figure 2.7 on the next page)	… Figure 2.7)
26	Bullet Point 3.3		As it tends to 1the two-step combustion model shift …	As it tends to 1, the two-step combustion model shifts …
28	2	last	particle tracking code is given …	particle tracking function code is given …
29	1	last	almost 15000×500 …	almost (by ignoring the thickness of the walls) …
31	Figure 3.6 Caption		Flow properties of the simulation at $t = 1.4958e-03$ $[s]$	Flow properties of the simulation at $t = 1.4958e-03$ $[s]$ (This simulation is based on ideal-gas hydrogen density)

32	2	2	pressure range of 1 to 75 bar …	pressure range of 0.1 to 7.5 MPa …
32	2	6	$p \approx 34\ [bar]$	$p \approx 3.4\ [MPa]$
33	2	2	… seem to be overestimated.	… seem to be overestimated, i.e. calculated temperatures are higher than the real case.
33	2	last	… chapter because first, explanations about	… chapter; because some explanations about …
34	1	1	… models and the Helmholtz function should be given, the shock-tube problem can be discussed.	models and also the Helmholtz function should be given beforehand, then the shock-tube problem can be discussed.
34	Figure 3.10 Caption		Flow properties of the simulation at $t = 1.4917e-03$ $[s]$, as a comparison to Figure 3.6	Flow properties of the simulation (based on real-gas hydrogen density) at $t = 1.4917e-03$ $[s]$; as a comparison to Figure 3.6 (ideal-gas hydrogen density)
35	2	5	solved in all CFD simulations	solved in conventional CFD simulations
35	4	3	diffusion terms of conservation equations, …	diffusion terms in conservation equations, …
35	4	4	… by calculating the Peclet number.	… by calculating the product of Lewis and Peclet numbers.
36	1	2	to compute the minimum Peclet number of the flow	to compute the minimum product's value of the flow
36	1	6	Based on these values the Peclet number of the flow	Based on these values the product of the Lewis and Peclet numbers
36	Equation 4.2		$Pe = \frac{L \cdot u}{D}$	$Le \cdot Pe = \left(\frac{\alpha}{D}\right) \times \left(\frac{L \cdot u}{\alpha}\right) = \frac{L \cdot u}{D}$
38	4	4	along the i, j, and k directions.	along the x, y, and z directions.
39	Bullet Points 3.1 & 3.2		3.1 … 3.2 …	❖ ❖
40	C++ Script, Bullet Point 1		\$(WM_PROJECT_USER_DIR)/src/reactionThermo/psiReaction	\$(WM_PROJECT_USER_DIR)/src/thermophysicalModels/react

			Thermo/psiReactionThermos.C	ionThermo/psiReactionThermo/psiReactionThermos.C
41	C++ Script, Bullet Point 4		$(WM_PROJECT_USER_DIR)/src/thermophysicalModels/specie/reaction/reactions/makeReactions.C	$(WM_PROJECT_USER_DIR)/src/thermophysicalModels/specie/reaction/Reactions/makeReactions.C
42	4.4.1.1 Heading		Two-Dimensional	Two-Dimensional Model
42	1	5	… surface of the nozzle,	… surface area of the nozzle,
42	1	5	… 3D circular one.	… 3D circular one (in order to deal with flow rate).
42	2	2	firstly, in the pseudo-three-dimensional wedge geometry	firstly, in the two-dimensional wedge geometry
44	3	2	will not perform properly at the explained initial …	will not perform properly and the explained initial …
44	4	2	but for these simulations,	but for this set of simulations,
44	4	last	The details of the sub-dictionaries …	The scripts of the sub-dictionaries …
45	4.4.5 Heading		4.4.5 fvSchemes	4.4.4.2 fvSchemes
45	3	5	for divergence schemes (except for the velocity and τMC) and interpolation schemes.	for divergence and interpolation schemes (except for the velocity and τMC).
45	4	2	are the numerical schemes used to …	are those used to …
45	4.4.6 Heading		4.4.6 fvSolution	4.4.4.3 fvSolution
45	6	2	relaxationFactors has to be used …	relaxationFactors parameter has to be used …
45	4.4.6.1 Heading		4.4.6.1 decomposeParDict	4.4.4.4 decomposeParDict
46-48	4.4.7 Heading and all the Sub-Headings		4.4.7 Constant Sub-Dictionaries 4.4.7.1 chemistryProperties 4.4.7.2 combustionProperties 4.4.7.3 reactions	4.4.5 Constant Sub-Dictionaries 4.4.5.1 chemistryProperties 4.4.5.2 combustionProperties 4.4.5.3 reactions

			4.4.7.4 thermophysicalProperties and thermo.compressibleGas 4.4.7.5 turbulenceProperties	4.4.5.4 thermophysicalProperties and thermo.compressibleGas 4.4.5.5 turbulenceProperties
47	3	3	(the real gas part will be added to this value based on the chosen equation of state) [36]:	(the residual part will be added to this value based on the chosen equation of state for calculating the real gas Cp) [36]:
47	4	4	the ideal-gas part of each value and the real-gas part will …	the ideal-gas part of each value and the residual part will …
47	5	1	There are two sets of janaf coefficients …	In the thermo.compressibleGas dictionary there are two sets of janaf coefficients …
47	7	last	are determined based on [39],	are determined based on reference [39],
48	2	1	The utilized values for the initial simulations as the Sutherland and Janaf coefficients …	Regarding the initial simulations, the utilized values for the Sutherland and Janaf coefficients …
51	3	2	the same cross-section for the reservoir	the same cross-sectional area for the reservoir
53	2	5	allow the solver goes below 250 K	allow the solver to go below 250 K
53	2	7	the only solution left is …	the only solution left was …
53	Figure 4.10 Caption		Temperature contours of two consecutive time steps, (a) before and (b) after the simulation termination	Temperature contours of two consecutive time steps, (a) before and (b) after the simulation termination for demonstrating the spurious discontinuities
54-55	Figure 4.11 Position		Last paragraph of section 4.6 is moved from page 55 to 54	Figure 4.11 is moved from page 54 to page 55
57	1	4	Although as it is shown, the Mach number …	Although as it is shown in the bottom diagram of Figure 4.13, the Mach number

58	3	3	Although these results do not have the same problems as the OF simulation, the values of the flow properties are overestimated.	These results do not have the same problems as the OF simulation (the minimum temperature and the flatten expansion curve), although the values of the flow properties are overestimated (they are higher than the real-case values).
60	3	7	… coefficients are tabulated in [44]. Besides, the detailed C++ dictionary implemented for this thermodynamic model in order to use for OF simulations is given in Appendix G.	… coefficients are tabulated in reference [44]. Besides, the C++ scripts of the implemented dictionary for this thermodynamic model are given in Appendix G, which will be used for the final OF simulations.
61	1	2	The detailed C++ dictionary implemented for this transport model in order to use for OF simulations is given in Appendix H.	the C++ scripts of the implemented dictionary for this transport model are given in Appendix H, which will be used for the final OF simulations.
62	1	last	are shown in Figure 4.16 and Figure 4.17.	are shown on the next page in Figure 4.16 and Figure 4.17.
65	1	8	(between hydrogen, oxygen, and nitrogen)	(between hydrogen and air)
67	2	1	In order to better visualizing the comparison between the results of this simulation and the initial 2D-simulation, the temperature range of Figure 4.21 (a) is changed to the interval of the temperature of the initial simulation, $[250 - 2500]\ K$,	In order to better visualize the comparison between the results of this final simulation and the initial 2D simulation, the temperature scale of Figure 4.21 (a) is manually changed to the interval of the temperature scale of the initial simulation, $[250 - 2500]\ K$,
68	1	1	initial simulation has propagated more than the final one.	initial simulation has propagated through the channel more than the final one.

70	last	1	it was shown that two-dimensional cylindrical axisymmetric simulation	it was shown that two-dimensional axisymmetric wedge simulation
71	1	4	smoothly pass through the sonic condition	smoothly pass through the transonic condition
72	3	4	Which may solve the sonic problem	which may solve the transonic problem
73-76	Access Links			Change all access links to hyperlinks

* Task description of the first semester:

University of South-Eastern Norway

Faculty of Technology, Natural Sciences and Maritime Sciences, Campus Porsgrunn

FMH606 Master's Thesis

Title: Spontaneous ignition of hydrogen-air

USN supervisors: Prof. Dag Bjerketvedt, and Prof. Knut Vågsæther

External partner and supervisor: FME- MoZEES (www.mozees.no)

Task background:

It is well known that high-pressure releases of hydrogen into the air may ignite spontaneously. However, the mechanisms causing the ignition is not well understood. In this thesis, the main objective is to study how shock waves and mixing can generate conditions favorable for ignition. This work is associated with hydrogen safety issues in MoZEES RA3 (www.mozees.no)

Task description:

- Literature review on spontaneous ignition of hydrogen-air
- Use CANTERA to estimate induction times in hydrogen-air mixtures as a function of pressure, temperature and hydrogen concentration
- Use the USN-FLIC code to estimate the flowfield when high-pressure hydrogen is released into the air. Conditions for ignition shall be evaluated.

Student category: Reserved for Keivan Afshar Ghasemi (continuation of a group project from fall 2019)

Practical arrangements:

Supervision:
As a general rule, the student is entitled to 15-20 hours of supervision. This includes the necessary time for the supervisor to prepare for supervision meetings (reading material to be discussed, etc.).

Signatures:

Supervisor: 2020-01-28 Dag Bjerketvedt

Student: Keivan Afshar Ghasemi Keivan A. Gh

2020-01-29