



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA



Assessment of LH2 transfer influence on tank self-pressurization and venting

Dissemination Conference

Lucas Claussner & Federico Ustolin

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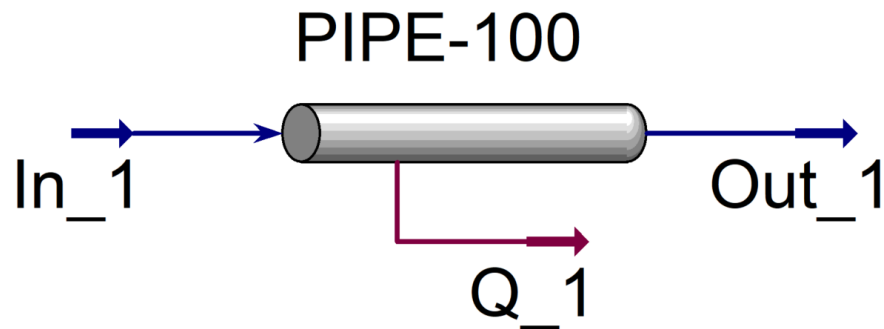


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1. Modelling of LH2 transfer operation

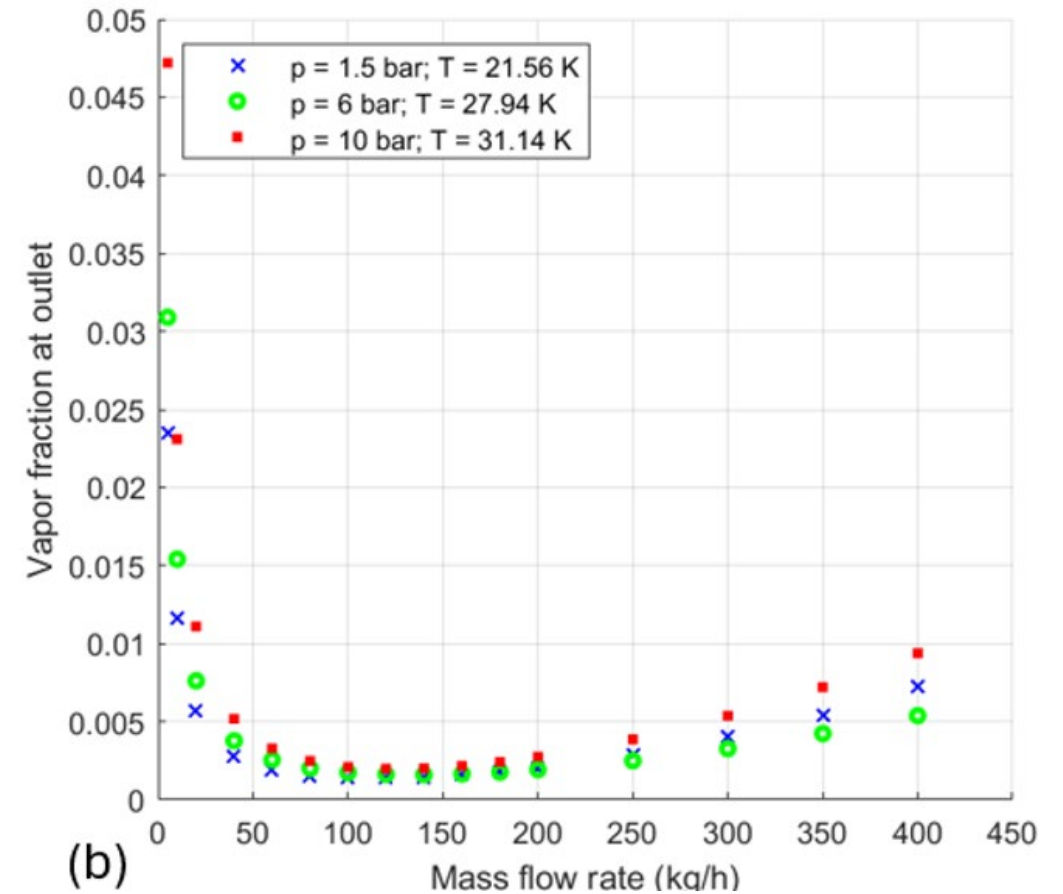
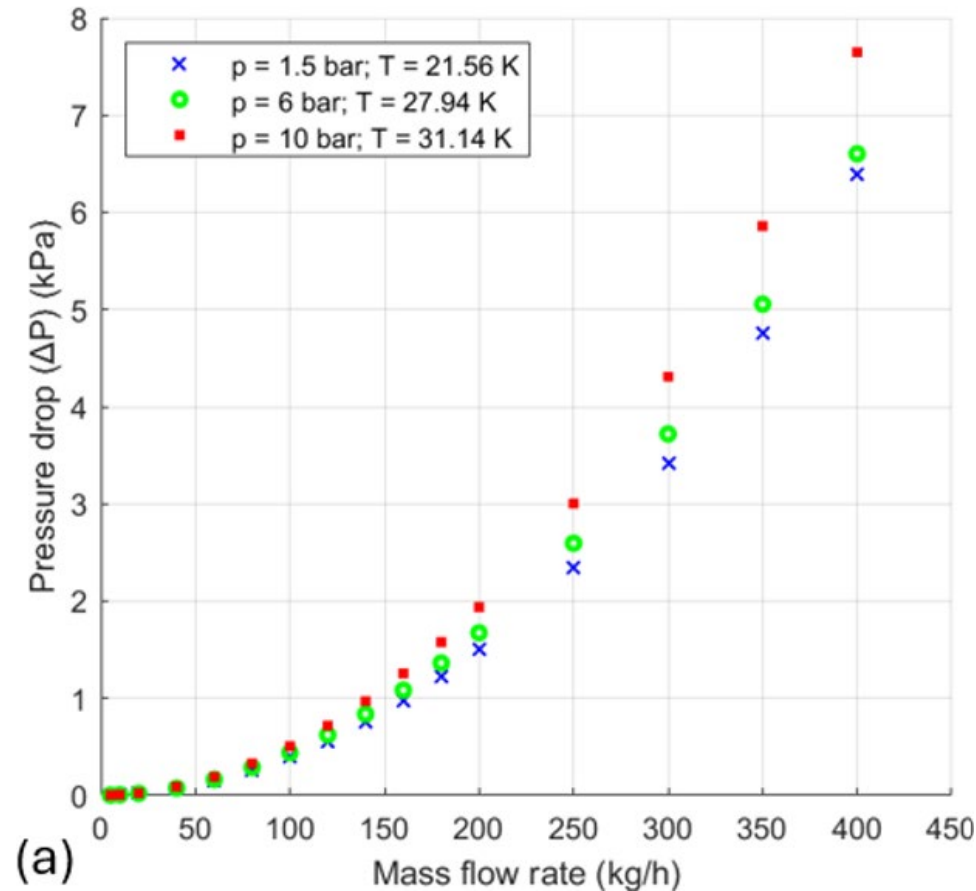
LH2 steady-state pipe simulation setup



Parameter	Value	Unit	Note
Length	20	m	Length of the rigid pipe
Elevation change	0	m	Pipeline position is considered horizontal
Outer diameter	45	mm	-
Inner diameter	25	mm	-
Pipe Material	-	-	ASTM A 240, type 316 L stainless steel
Roughness	1.500e-005	m	Roughness of inner pipe wall
Pipe wall conductivity	16.30	W/m·K	-
Insulation type	Evacuated annulus	-	-
Thermal conductivity of insulation	5e-004	W/m·K	-
Insulation thickness	50	mm	-
Mass flow rate	5-400	kg/h	-
Pressure	1.5, 6.0, 10.0	bar	-
Temperature	21.56, 27.94, 31.14	K	-

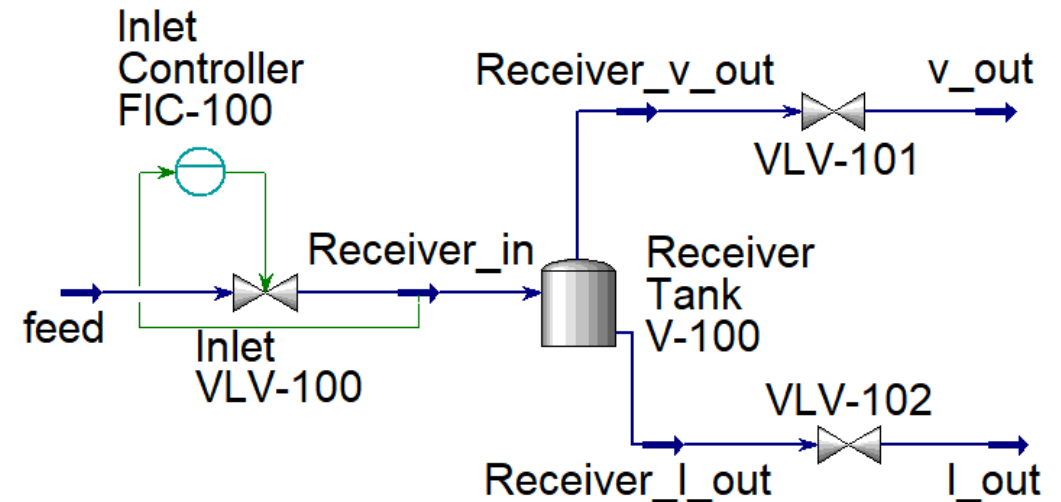
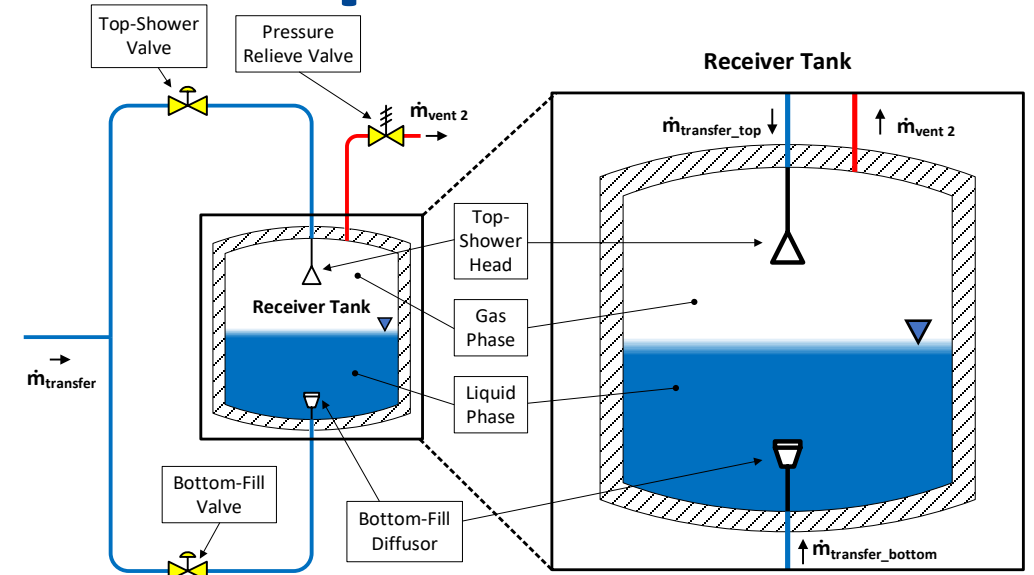
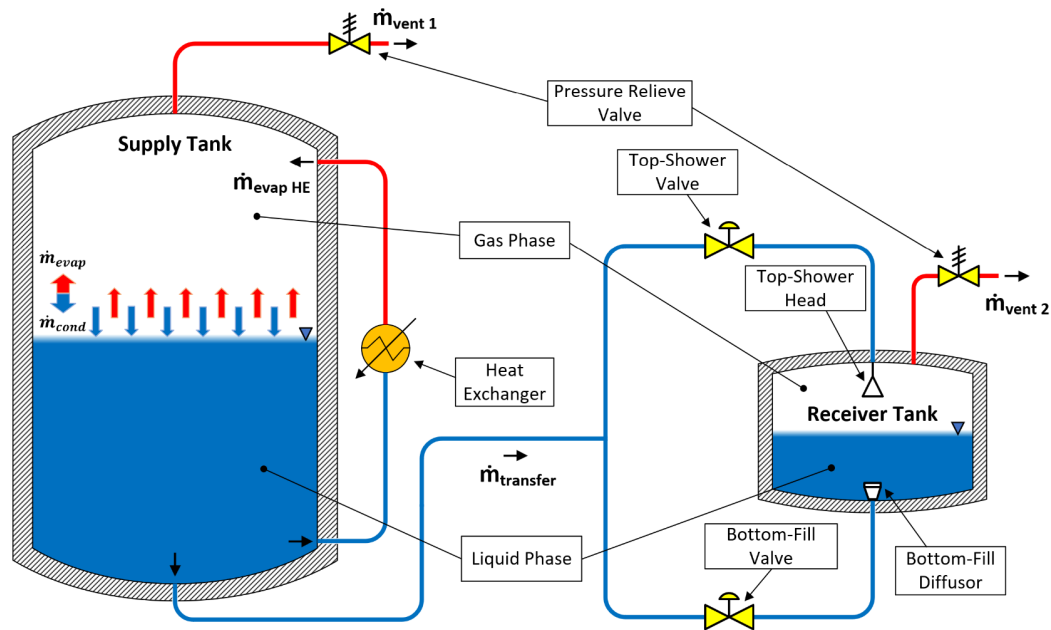
1. Modelling of LH2 transfer operation

LH2 steady-state pipe simulation



2. Modelling of LH2 transfer operation

Dynamic tank fill simulation setup

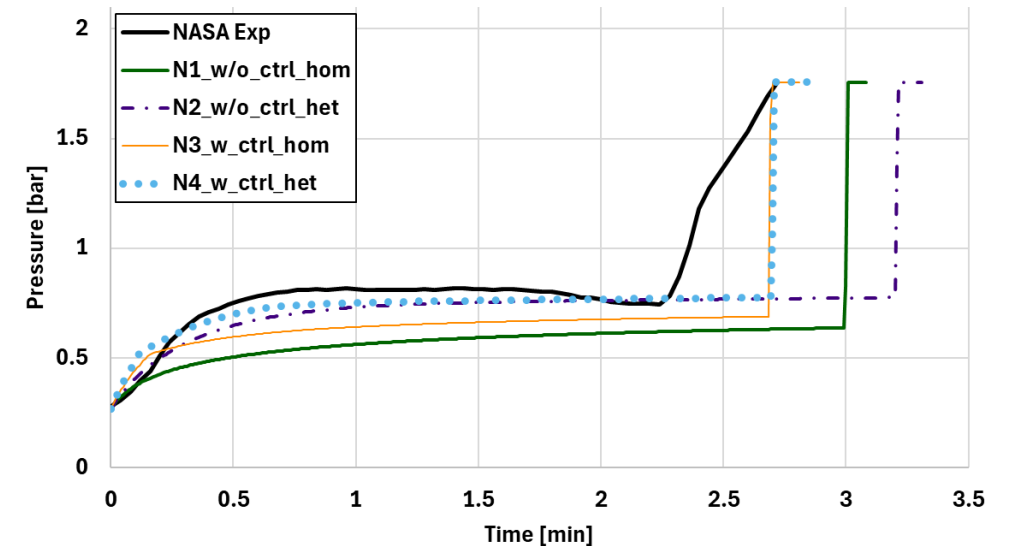
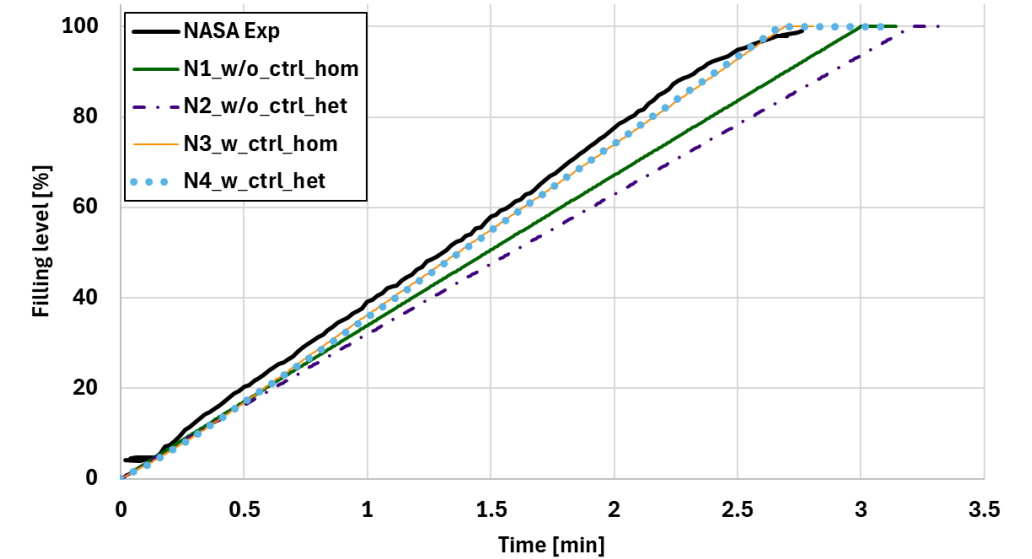


2. Modelling of LH2 transfer operation

Dynamic tank fill simulation validation

	feed	Receiver_in
Vapor quality	0.000	0.093
Temperature [K]	19.00	16.63
Pressure [bar]	1.756	0.269
Mass flow [kg/h]	54.43	54.43

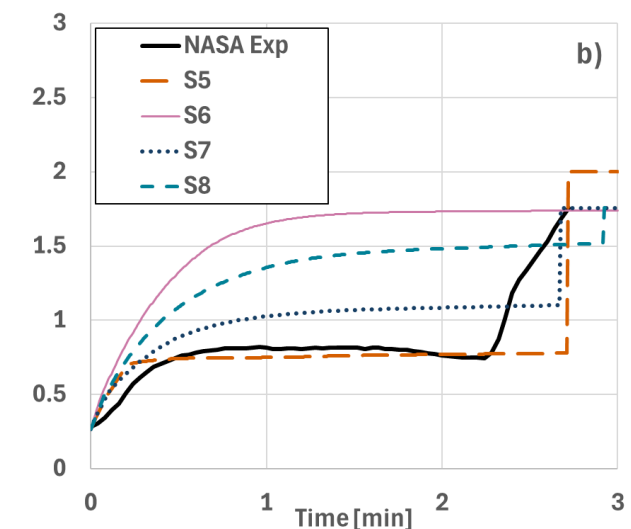
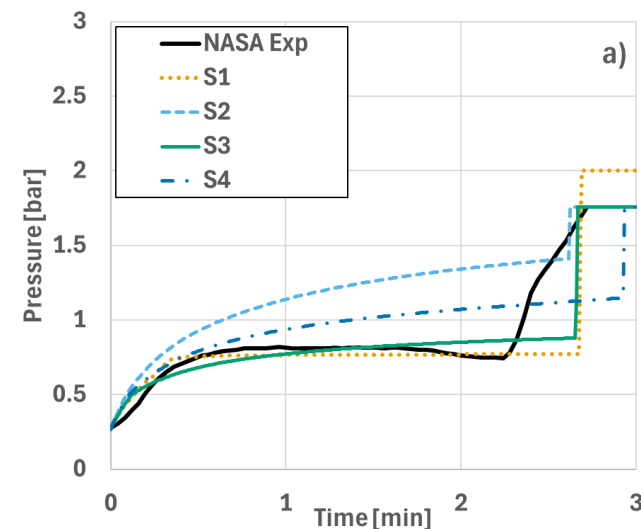
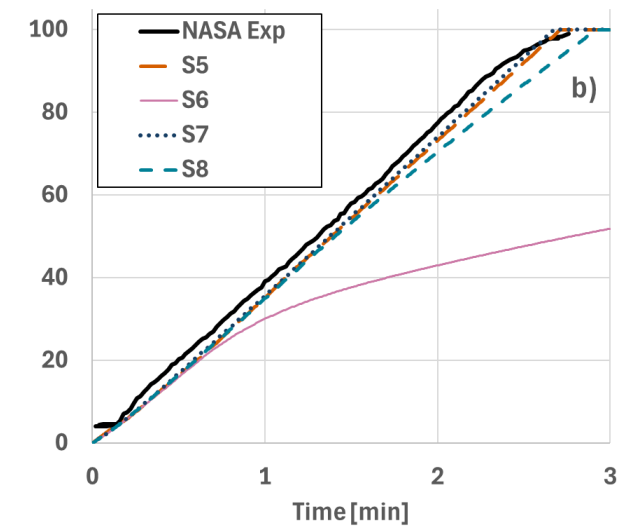
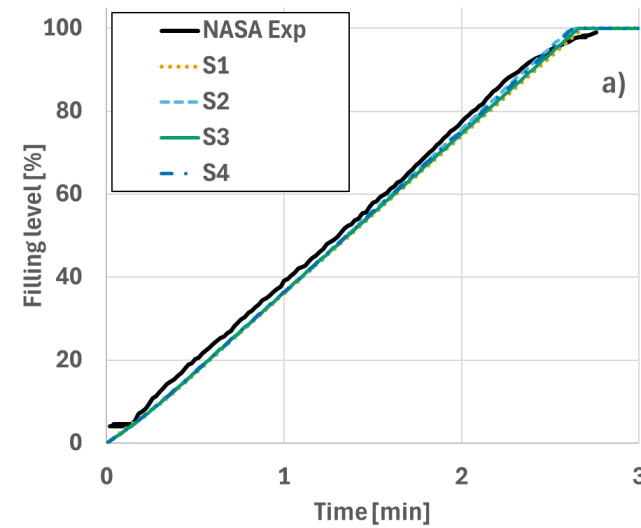
Simulation	Mass flow dyn. controlled [Yes/No]	Temperatures in tank
N1_w/o_ctrl_hom	No	Homogeneous
N2_w/o_ctrl_het	No	Heterogenous
N3_w_ctrl_hom	Yes	Homogeneous
N4_w_ctrl_het	Yes	Heterogenous



2. Modelling of LH2 transfer operation

Dynamic tank fill simulation sensitivity analysis

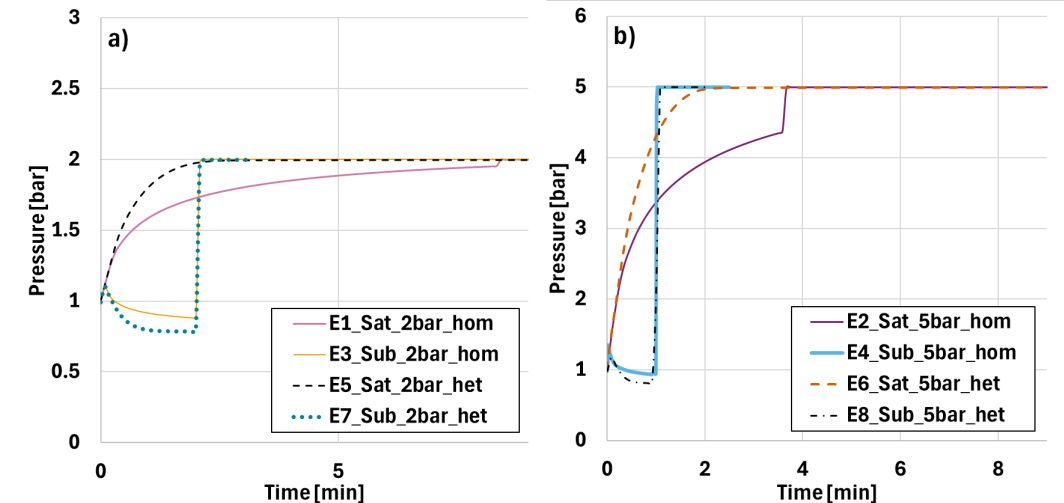
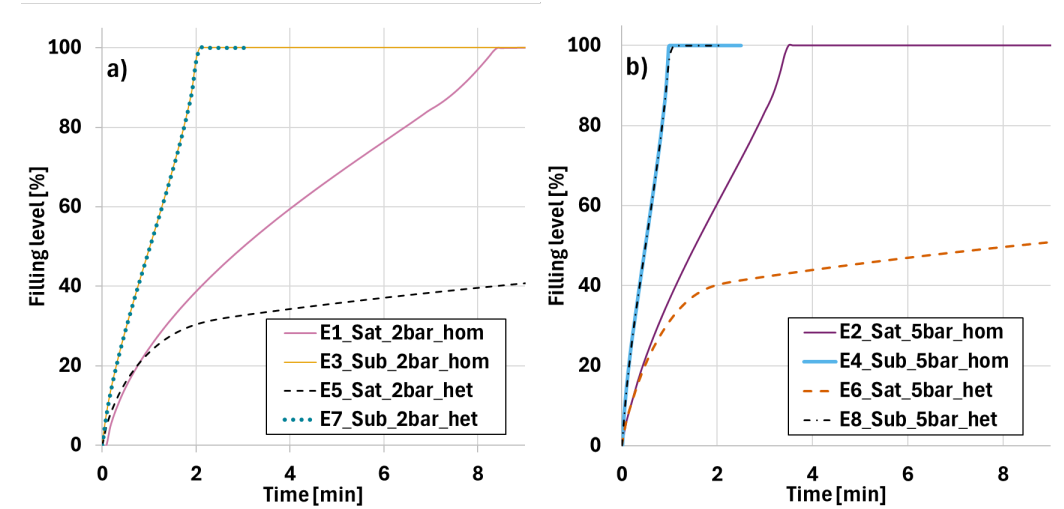
Simulation	Mass flow dyn. controlled [Yes/No]	feed temp. [K]	feed press. [bar]	Temperatures in tank
S1_hom	Yes	19	2.000	Homogeneous
S2_hom	Yes	22	1.756	Homogeneous
S3_hom	Yes	20	1.756	Homogeneous
S4_hom	Yes	21	1.756	Homogeneous
S5_het	Yes	19	2.000	Heterogenous
S6_het	Yes	22	1.756	Heterogenous
S7_het	Yes	20	1.756	Heterogenous
S8_het	Yes	21	1.756	Heterogenous



2. Modelling of LH2 transfer operation

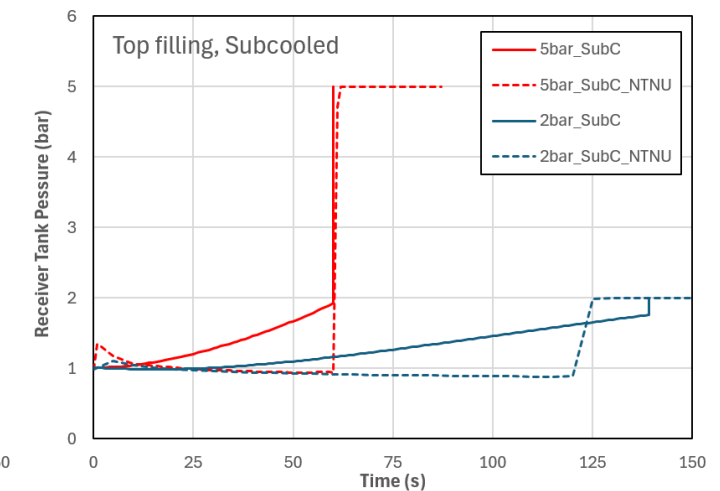
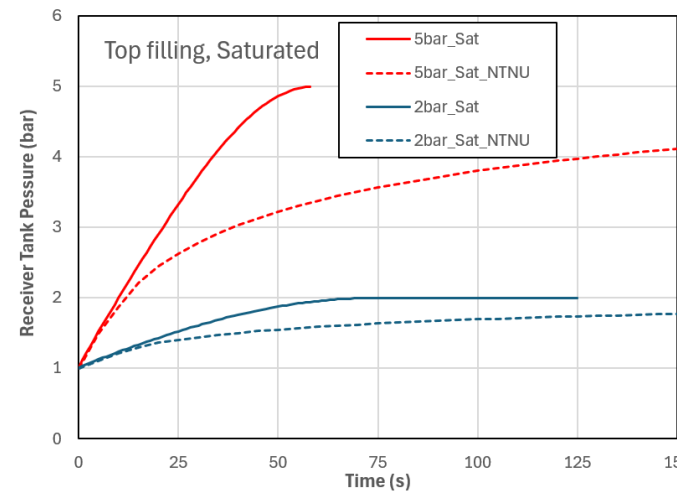
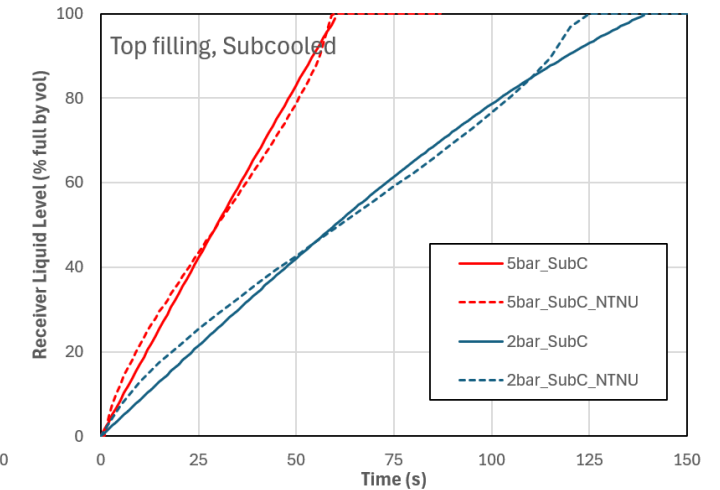
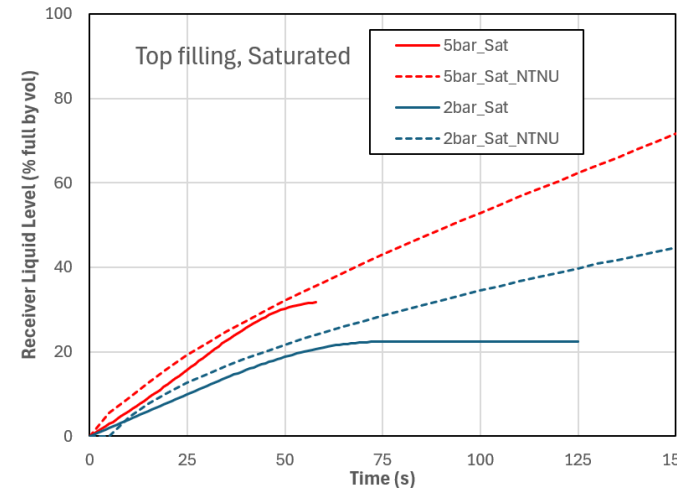
Dynamic tank fill simulation ELVHYS blind simulation

Simulation name	LH2 status	feed temp. [K]	feed press. [bar]	Initial Receiver_in temp. [K]	Initial Receiver_in press. [bar]	Mass flow [kg/h]	Temperatures in tank
E1_Sat_2bar_hom	Saturated	22.67	2.000	20.17	1	450	Homogeneous
E2_Sat_5bar_hom	Saturated	26.93	5.000	20.17	1	720	Homogeneous
E3_Sub_2bar_hom	Subcooled	19	2.000	20.16	1	828	Homogeneous
E4_Sub_5bar_hom	Subcooled	19	5.000	20.14	1	1710	Homogeneous
E5_Sat_2bar_het	Saturated	22.67	2.000	20.17	1	450	Heterogenous
E6_Sat_5bar_het	Saturated	26.93	5.000	20.17	1	720	Heterogenous
E7_Sub_2bar_het	Subcooled	19	2.000	20.16	1	828	Heterogenous
E8_Sub_5bar_het	Subcooled	19	5.000	20.15	1	1710	Heterogenous



2. Modelling of LH2 transfer operation

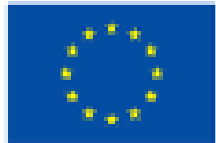
Dynamic tank fill simulation Comparison with DISCHA





Thank you for your attention

lucas.claussner@ntnu.no



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