Department of Mechanical Engineering

Mini Project: Hydrogen Refueling Analysis of Fuel Cell EV (FCEV) Tanks

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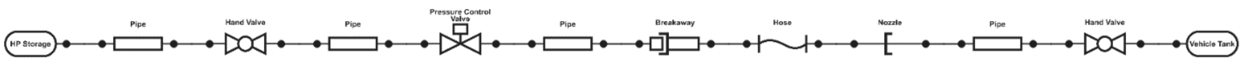
1. Introduction to H2FillS.

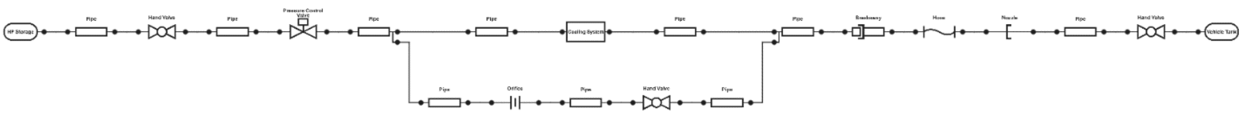
H2FillS: The Hydrogen Filling Simulation (H2FillS) software is a thermodynamic model designed to track and report on the transient change in hydrogen temperature, pressure, and mass flow when filling a fuel cell electric vehicle (FCEV). H2FillS simulates gas flow from the hydrogen station to the FCEV storage system. Using empirical fueling data sets, the model has been validated over a range of fueling conditions to match common light-duty FCEV fill profiles.

Full Station Models: The full-station model has four configurations available.

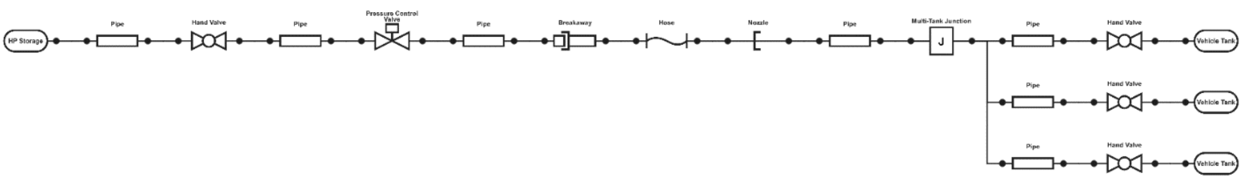
a) **Series configuration:** A series configuration is the simplest configuration which demonstrates the minimum required components to run the simulation



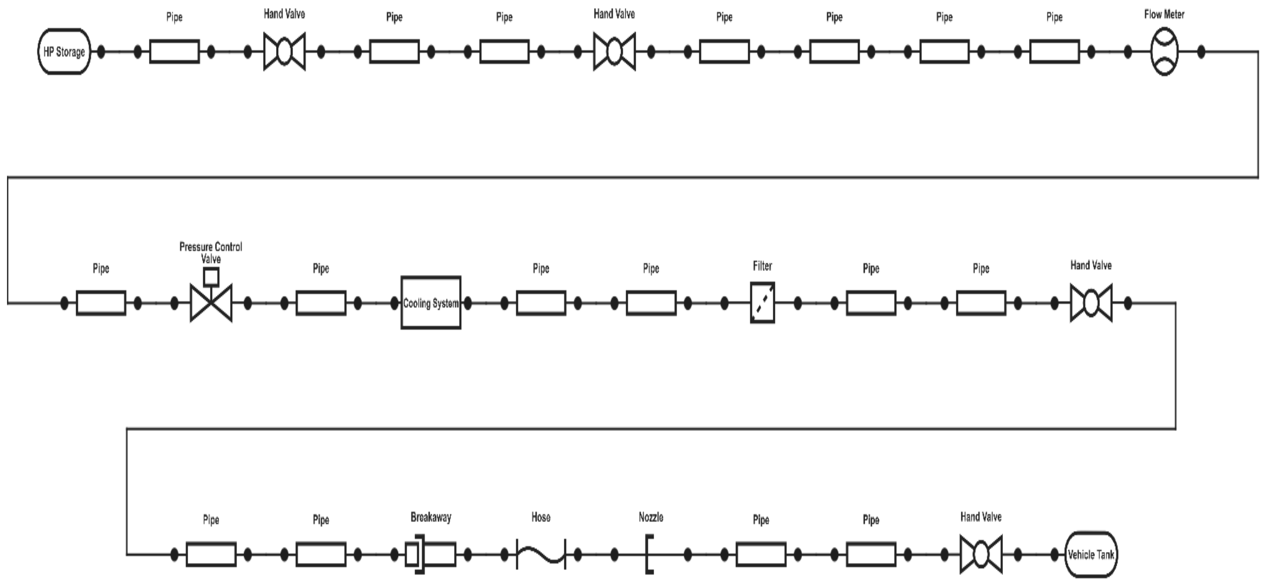
b) **Parallel configuration:** A parallel configuration demonstrates a capability of splitting flows prior and subsequent of a cooling system.



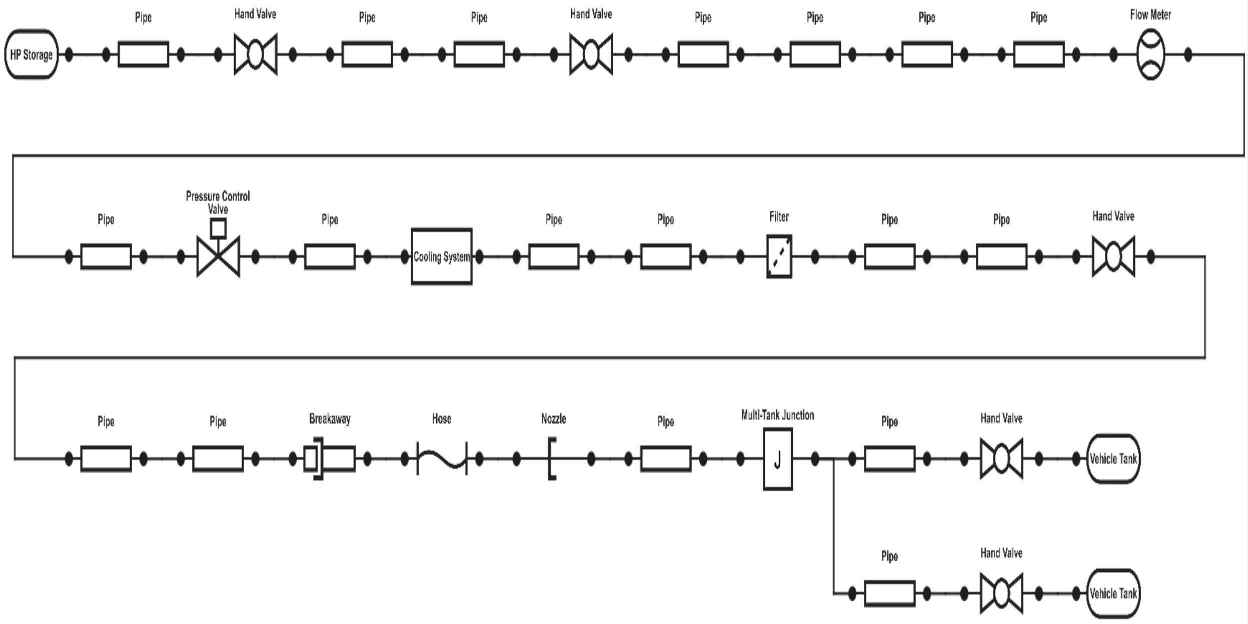
c) **Multi-Tank configuration:** This demonstration shows a configuration that uses a multi-tank junction to simulate filling multiple vehicle tanks.



d) NREL Single Tank configuration: This demonstration shows a configuration based on NREL HITRF (hydrogen infrastructure testing and research facility).



e) NREL Multi-Tank configuration:



State of Charge (SoC) variation for different Pressure Ramp Rate (PRR) in NREL based Single Tank Configuration.

Vehicle Tank: Type IV 4kg SAE J2601 Tank

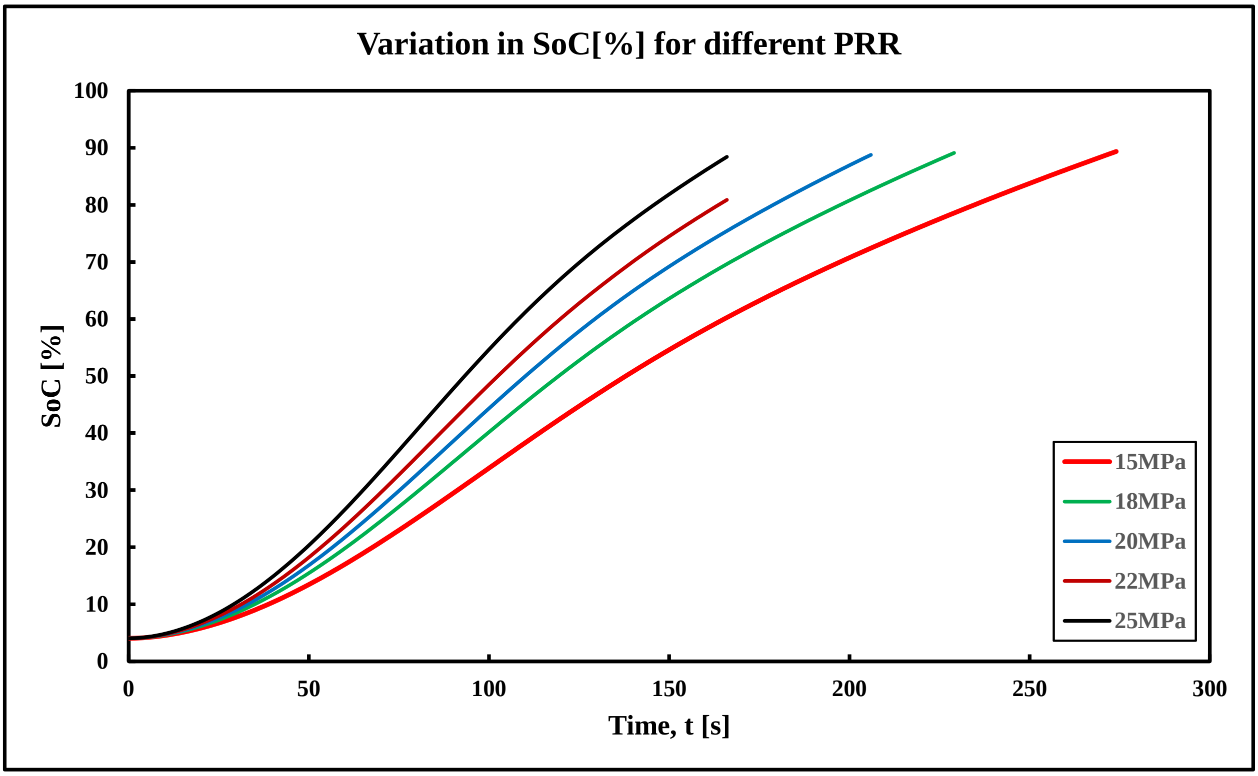
Input Parameters:

Table 1:

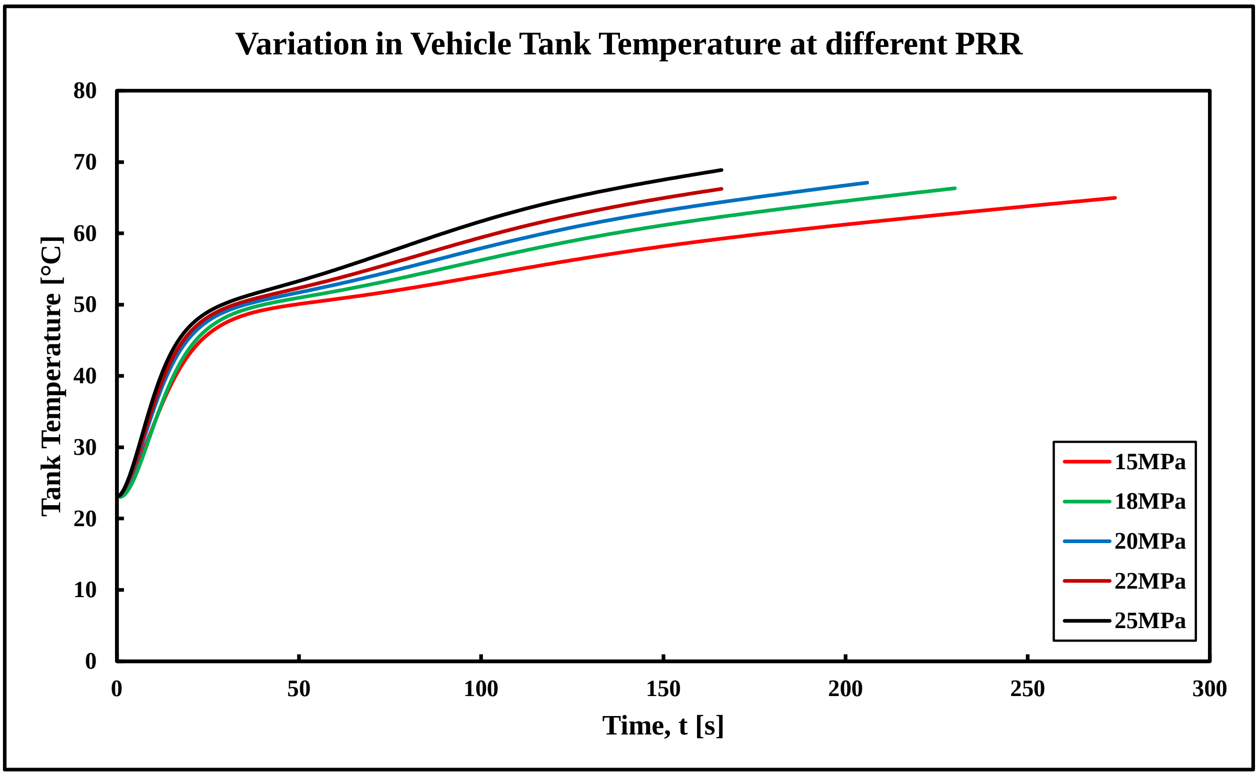
Fill Profile/Component	**Parameter**	**Value**
Fill Condition	Ambient Temperature [degC]	20
Fill Condition	Terminating Condition: Pressure [MPa]	70
High Pressure Tank Storage	Pressure [MPa]	90
Cooling System: 1	Outlet Temperature [degC]	-40
Vehicle Tank	Convective Heat Transfer Coefficient [W/(m^2 K)]	8
Vehicle Tank	Composite Density [kg/m^3]	1494
Vehicle Tank	Liner Density [kg/m^3]	945
Vehicle Tank	Diameter [m]	0.42
Vehicle Tank	Inside Surface Area [m^2]	1.1
Vehicle Tank	Pressure [MPa]	2
Vehicle Tank	Composite Specific Heat [J/(kg K)]	1120
Vehicle Tank	Liner Specific Heat [J/(kg K)]	2100
Vehicle Tank	Tank Length [m]	0.855
Vehicle Tank	Temperature [degC]	23
Vehicle Tank	Composite Thermal Conductivity [W/(m K)]	0.5
Vehicle Tank	Liner Thermal Conductivity [W/(m K)]	0.5
Vehicle Tank	Composite Thickness [m]	0.0316
Vehicle Tank	Liner Thickness [m]	0.005
Vehicle Tank	Volume [m^3]	0.099
Fill Condition 1	**Pressure Ramp Rate [MPa/min]**	**15**
Fill Condition 2	**Pressure Ramp Rate [MPa/min]**	**18**
Fill Condition 3	**Pressure Ramp Rate [MPa/min]**	**20**
Fill Condition 4	**Pressure Ramp Rate [MPa/min]**	**22**
Fill Condition 5	**Pressure Ramp Rate [MPa/min]**	**25**

Results:

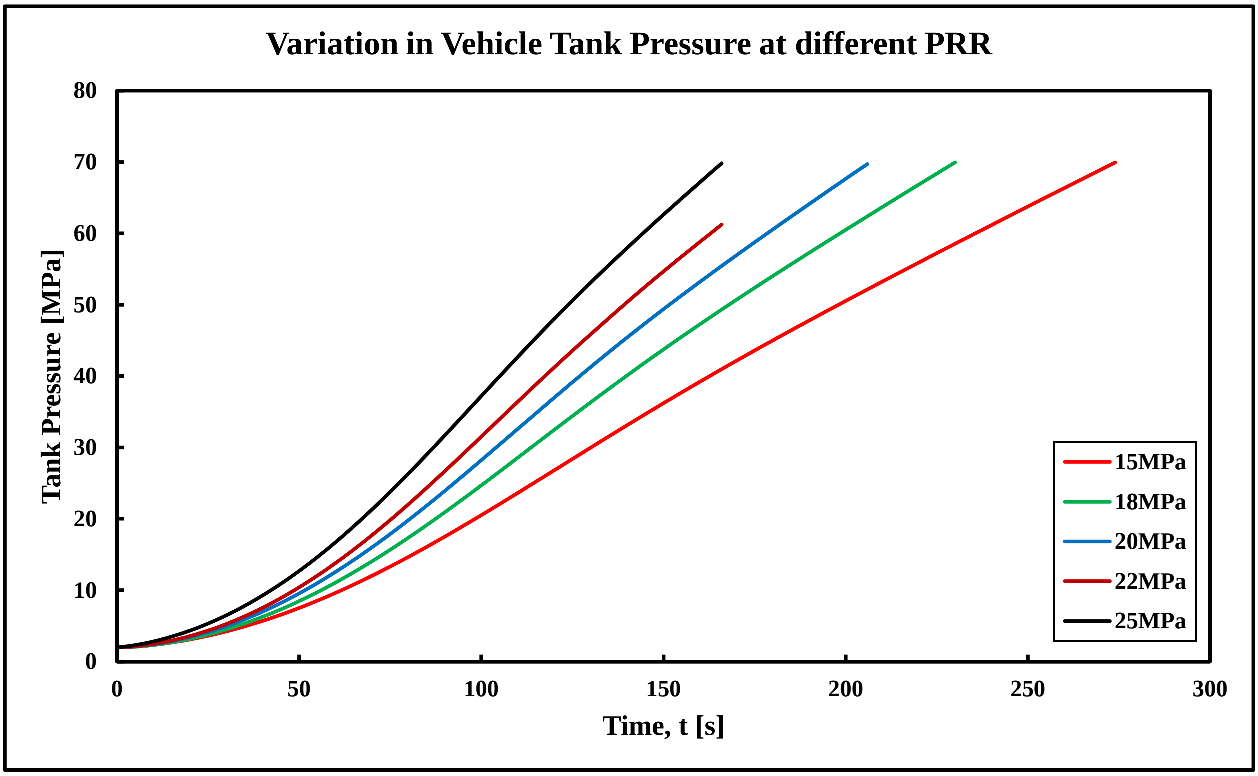
1. **Variation in SoC-% at different pressure ramp rates [PRR]**



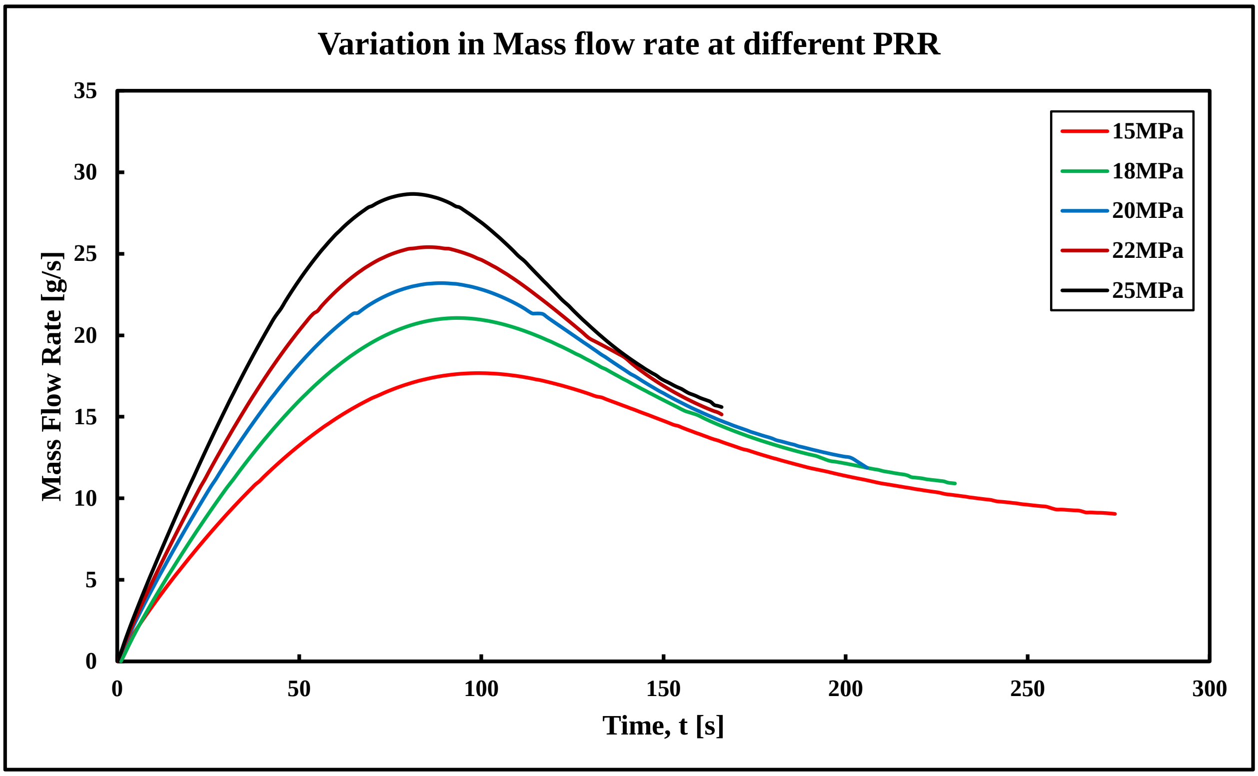
2. **Variation in Vehicle Tank Temperature at different PRR**



3. Variation in Vehicle Tank Pressure at different PRR



4. Mass flow rate at different Pressure Ramp Rate [PRR]



Conclusions:

1. **90% SoC is achieved in minimum time for higher pressure ramp rates.**
2. **For higher PRR, vehicle tank temperature is higher in short time.**
3. **For higher PRR, vehicle tank pressure is higher in short time.**
4. **Higher mass flow rate is achieved at higher PRR.**

THANK YOU