HAN dynamic house model: Buffervessel

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Contents

1 Introduction

This document describes the buffer vessel model that can be incorporated into the HAN dynamic house model.

2 Model description

The model for the buffer vessel is derived from the paper of Rakesh Sinha et al. [**empty citation**]

The model consist of a heating element, located outside of the buffer vessel, which can take water from the vessel and heat the water to a desired temperature.The hot water is then injected to the top of the buffer vessel.

Hot water is is taken from the top of the buffer vessel on the demand side. Cooled water coming from the load is returned tot the bottom of the vessel.

A schematic description of the buffer vessel is shown below.

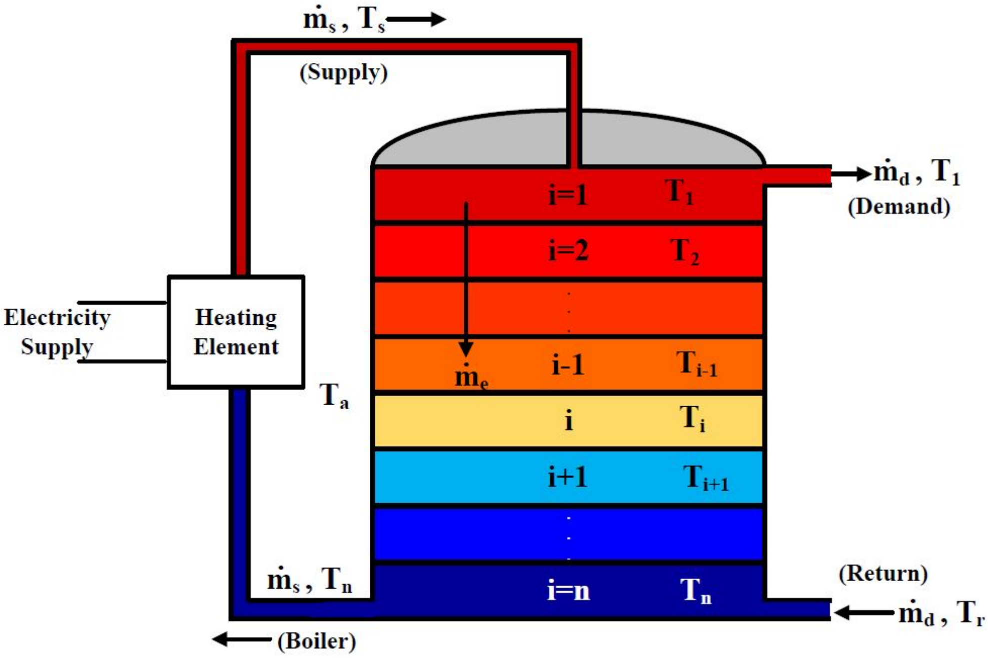


Figure 1: Buffer vessel representation

Due to the fact that the density of water with different temperature layers are created.

In order to model this, the buffervessel will be divided into N-different sections

3 Mathematical description

For the top layer:

$$mC_w\frac{dT_1}{dt} = \dot{m}_sC_w(T_s - T_1) + \dot{m}_eC_w(T_1 - T_2) * sgn(-\dot{m}_e) - UA_s(T_1 - T_a) - \frac{A_q\lambda_w}{z}(T_1 - T_2) \tag{1}$$

For the middle layers:

$$mC_w\frac{dT_i}{dt} = \dot{m}_eC_w(T_{i-1} - T_i) * sgn(\dot{m}_e) + \dot{m}_eC_w(T_i - T_{i+1}) * sgn(-\dot{m}_e) - UA_s(T_i - T_a) + \frac{A_q\lambda_w}{z}(T_{i-1} + T_{i+1} - 2T_i) \tag{2}$$

For the bottom layer:

$$mC_w\frac{dT_n}{dt} = \dot{m}_d C_w(T_r - T_n) + \dot{m}_e C_w(T_{n-1} - T_n) * sgn(\dot{m}_e) - UA_s(T_n + T_a) + \frac{A_q\lambda_w}{z}(T_{n-1} - T_n) \tag{3}$$

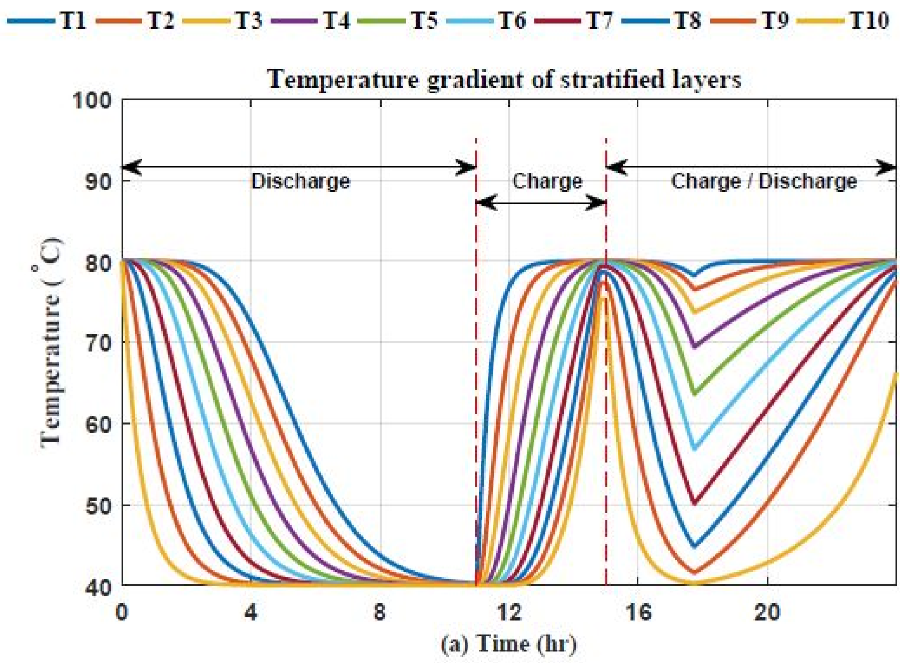
4 Validation

To check to model from the paper, the following parameters are used:

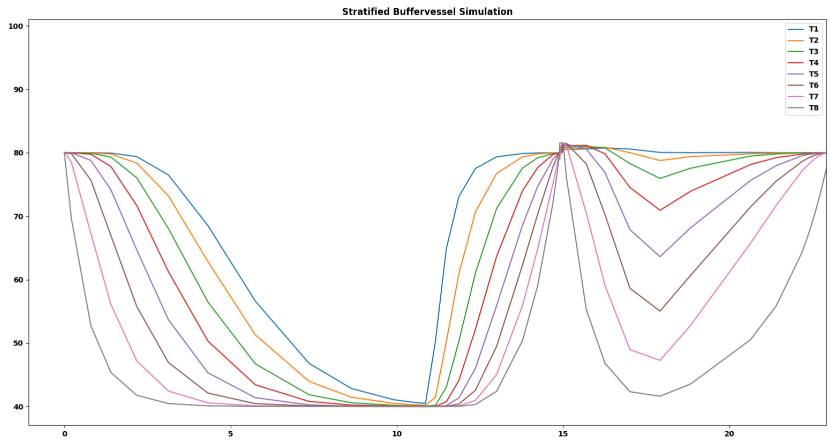
Parameters	Definition	Value	Units
V	storage volume	200	[m^3]
n	number of stratified layers in storage tank	10	-
λ_w	effective heat conductivity of water	0.644	[W/mK]
U	heat transfer coeff. of the storage walls	0.12	[W/m^{2}K]
x	diameter to height ratio of storage	2.24	-
T_a	ambient Temperature	10	[°C]
x T_s	supply Temperature	80	[°C]
T_r	return Temperature	40	[°C]
P_b	Rated Power of EB	2.4	[MW]
C_w	specific heat capacity of water	4190	[J/kg·K]

Figure 2: Buffer vessel parameters

This results in the following graph:



(a) paper results



(b) Python results

Figure 3: Comparison between paper and python model