Fueling Analysis

H2@Ports Workshop
September 2019

9/11/19

Assumption

Acceptable industry standards for industrial and operator safety are used

Class 7-8 Truck Fueling Patterns

Type of vehicle / location of fueling	Number of vehicles using station/day	Expected back-to-back fuelings	Acceptable fueling time per fueling	Additional feedback
Short-haul, drayage, line-haul / fleet yard	Depends on size of fleet	Peak-times at end and beginning of day	10-15 min	Diesel dispenser max flow rate: 22-63 gal/min (63 gal with dual hoses)
Short-haul, drayage, line-haul / truck stop	Majority of truck stops have 8-10 dispensers	Depends on truck operator schedule and peak times at truck stop	10-15 min	Truck stop "number of vehicles/day" is industry confidential information
Long-haul – truck stop	Majority of truck stops have 8-10 dispensers	Throughout the day, with peak-times from 5:00-6:00AM and 4:00-5:00PM	~10 min	Long-haul truckers start to pile in order to get a parking spot to sleep overnight. Truck operators not very flexible with the fueling operations, nor are fueling station operators. People get frustrated when a truck is in fueling bay for more than about 10 min. There are self-imposed rules that the drivers usually follow.

Class 8 Truck Fueling Times

Range of average filling times (in min)	**Diesel (ambient pressure)**				**CNG (250 bar)**		**LNG (cryo)**	**Range (miles)**
Average amount dispensed	50 gal single hose	75-80 gal single hose	100-150 gal single hose	200-300 gal dual/2 hoses	50 GGE single hose	100-150 GGE single hose	118 gal single hose	N/A
Class 8 truck - drayage/short-haul line-haul	**10**	**-**	**10-12**	**-**	**10**	**10-15**	**-**	**200-400 500-600**
Class 8 truck - LNG long-haul	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**≤700**
Class 8 truck - diesel long-haul	**-**	**-**	**-**	**10-15**	**-**	**-**	**-**	**≤1,400**
HD transit bus	**5-7**	**5-7**	**-**	**-**	**2.5-8**	**4-10**	**-**	**150-350**

How to Fast Fill Trucks?

In current operational use

- 350 bar: up to 120g/s, 5-10 min fill for 30-60kg

In development for commercial operational use

- 700 bar: up to 200-300g/s, 10-15 min fill for 60-100kg

Existing but limited/no current commercial development

- Liquid H2 (near ambient up to 7-10 bar)
- Cryo Compressed H2 (today up to 350 bar, future up to 700 bar?)

Maritime Vessel Fuel Needs

Type of vessel (length in feet/meters)	Fuel capacity (gal)	Fueling time	H2 fueling time
Small speedboat (12–20 / 3-6)	6–20	5 min	
Sailing yacht (33–45 / 10-13)	30–120	10-20 min	
Motor yacht (40–60 / 12-18)	200–1,200		
Small tugboat (30–60 / 9-18)	1,500–25,000		
Large tanker truck / petroleum rail car	5,000–10,000 / 30,000		
SF Bay ferry Water-Go-Round (70 / 21)	264 kg (250 bar)		30-60 min
Ocean-going tugboat (90–150 / 27-45)	90,000–190,000		
Puget Sound jumbo ferry (440 / 134)	130,000		
Yacht M/V Octopus (416 / 127)	224,000		
Bulk commodities carrier (500–700 / 152-213)	400,000–800,000		
Large cruise ship (900–1,100 / 274-335)	1–2 million		
Inland tank barge (200–300/ 61-91):	400,000–1.2 million		
Panamax container ship (960 / 293)	1.5–2 million		
Container ship Benjamin Franklin (1,310 / 399)	4.5 million		
Ocean-going tank barge (550–750 / 168-229)	7–14 million		

Source: Washington State Department of Ecology report / US DOC NOAA Office of Response and Restoration

How to “Fast Fill” Maritime Vessels?

In current operational use

- 250 bar: up to 60g/s if SAE J2600 – other connectors faster
- 350 bar: up to 120g/s, 5-10 min fill for 30-60kg
- 500 bar: high rate fueling of tube trailers
  - At H2 plant or retail station for transfer of H2 from LH2
- 250-500 bar composite or steel vessels trailer swap
- 250-500 bar ISO container with composite vessels swap
- LH2 transfer (pumped or gravity)
- LH2 cryo-pump to gaseous transfer

Future

- 700 bar for maritime?
- CcH2?
- H2 carriers?
- LH2 production at port – space shuttle-like fueling?
- LH2 trailer/container swap?

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CaFCP Members

— 20 years of collaboration —

- Trillium / Love's direct communication about CNG and diesel fueling times for Class 8 trucks (operator of ~395 truck stops)
- LNG fueling online sources:
  - http://www.cryostar.com/web/lcng-lng-filling-stations.php
  - https://www.cleanenergyfuels.com/wp-content/uploads/2017/03/LNG-Station-Brochure_Digital.pdf
  - http://www.prometheusenergy.com/_pdf/LNGQuickFacts.pdf
- Technical specifications diesel dispensers from major dispenser OEMs
  - https://wayne.com/media/1146/wayne-select-fleet-dispenser_2014-07-21.pdf
  - http://www.gilbarco.com/gold/download.cfm?doc_id=5076
  - https://www.bennettpump.com/files/3000-series/3000-series-brochures/216-3000-series-brochure/file
  - https://www.bennettpump.com/files/3000-series/3000-series-brochures/159-big-fueler-brochure/file
- Layout truck stop dispensers
  - https://www.bennettpump.com/files/3000-series/3000-series-brochures/170-3000-series-big-fueler-truck-stop-layout-diagram/file