NPRE 470 HW #3 Solution

1. Ideal gas Law

$$PV = NRT$$

one mole of ideal gas @ STP (273k, 1atm) has a volumn of 22.4 L.

$\because$ $V \propto T$,

$\therefore$ 1 mole of H_2 @ (298k, 1atm) has a volumn of $22.4L \frac{298}{273} = 24.45\,L$

1 mole of H_2 = 2 gram

☆ There fore, the volumetri density @ 1 atm is

$$= \frac{0.002\,kg}{24.45} = 0.0000818\ kg/litre$$

☆ 3000 psi = 3000 / 14.696 = 204.1 Atm

Vol. density = $0.0000818 \cdot 204.1 = 0.0167$ kg / litre

☆ 5000 psi :

Vol. den. = 0.0278 kg / litre

☆ 7000 psi :

Vol. den. = 0.03896 kg / litre

☆ 10000 psi : Vol. den = 0.0557 kg/litre

All are smaller than Liquified H_2 density.

2. Total energy for 500M @ 60MPH and 5KW

$$E = 5KW \times 3600 \times 500/60$$
$$= 1500,000,000\ J = 150[illegible]MJ$$

$$2H_2 + O_2 \rightarrow 2H_2O \quad (\text{suppose in liquid form})$$

ΔG $\quad -237.1$ KJ/mol

@ 50% efficiency. 2 mole of H_2 generate 237.1 KJ

Hence we need $\dfrac{1500\text{ MJ}}{237.1\text{ KJ/2mol}} = 1265{,}2.$ mole of H_2

☆ which is $\boxed{2.53\text{ kg.}}$

$$NaBH_4 + 2H_2O \rightarrow NaBO_2 + 4H_2$$

1mol (37.83) $\qquad\qquad$ 4mol

In order to make 1265.2 mole of H_2 we need

1265.2./4 = 316.3. moles of $NaBH_4$

☆ which is 316.3 × 37.83 = 11966.4 g = $\boxed{11.966\text{ kg}}$

Now need to find out what a 6%-H-content solution is made of.

$+ xH_2O$ (balence water)

$$NaBH_4 + 2H_2O \rightarrow NaBO_2 + 4H_2$$

$$\underbrace{37.83 + (x+2)\cdot 18}_{\text{total weight}} \qquad 8$$

②

So need to find out what x will make

$$\frac{8}{8+37.83+18(x+2)} = 6\%$$

Easily solvable:

$$\frac{8}{18X+81.83} = 6\%$$

$$18X+81.83 = 133.33$$

$$18X = 51.50$$

Hence $18X+81.83 = 133.33$

or to make 8 grams of H_2 we need 133.33 gram of $NaBH_4$ solution.

Therefore, the total amount of $NaBH_4$ to drive the car is ~~2.53~~ 2.53 kg $\frac{133.33}{8} = \boxed{42.167\ \text{kg.}}$

The fuel only energy density of the f.c. system is

$$41.667/42.167 \approx \boxed{988\ \text{Whr/kg}}.$$

So it's ~ one order of magnitude higher.

The End.