Pressure Reducing Station Design for small scale business from 200 bar to 2 bar pressure

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Abstract

This research aims to create a design tool for pressure reducing station for tube cradle 200 bar where the initial temperature of the CNG is -40°C. As an environmentally friendly fuel, many advantages gained when using CNG, among others: huge gas reserves, produced in the country, it's cheap, and friendly environment. Reducing pressure from 200 bar to usable pressure at 2 bar never been easy as cheap. Small business-like restaurants and caterings are looking for fuel sources that cheap and safe in usage. CNG in distribution are tubed in 200 bar cradle and not easy to use instantly, despite its cheap price and high calorie given.

These studies are either research and development methods and the results of this research generate a pressure reducing station, which can lower the pressure to 2 bar. By discharging it into heat pump system, reducing pressure from 200 bar to 2 bar in cheap and safe way are acomplished. The reducing station has been tested as heat exchanger and volume control to maintain it safety and performance. It discusses the process of testing the pressure reducing station, which includes the maximum temperature of water, temperature of gas in the tubing before and after passing the heat exchanger, temperature of the gas in the container header, final temperature of the gas after exiting the regulator, determining the discharge of gas that comes out for 1 minute and the height of the fire. Temperature testing uses a thermocouple tool calibrated with Arduino Uno.

The results of the study are specifications of pressure reducing station equipment, as follows: Maximum temperature of water: 76.5 °C, temperature of gas in the tubing before passing through the heat exchanger for 5 stage gate opening: 34.75 °C - 35.75 °C, then after heat exchanger: 54.25 °C - 54.75 °C, gas temperature in the header: 36.78 °C, final gas temperature in the regulator: 45.75 °C, gas discharge testing for 5 stage gate opening: 13 m3 - 24 m3 and fire height testing for 5 stage gate opening : 33 cm - 56 cm.

Key words: pressure drop, pressure reducing station, compressed natural gas, small scale business.

1. Introduction

Gas is one of the fuels that has recently been increasingly developed in Indonesia as an alternative energy. Gas fuel itself consists of two types, namely Compressed Natural Gas (CNG) and Liquid Petroleum Gas (LPG). CNG is made by compressing CH_4 methane extracted from natural gas. Whereas LPG, its main components are dominated by propane C_3H_8 and butane C_4H_{10}, with other light hydrocarbon contents such as ethane C_2H_6 and pentane C_5H_{12}. Compressed Natural gas or CNG is a fuel derived from natural gas with the main element of methane gas being compressed, maintained and stored in a specially designed pressure vessel. CNG contains the main components in the form of methane CH_4 and ethane C_2H_8. CNG is made by compressing methane extracted from natural gas (S. Zaini, et al., 2013). CNG has a higher hydrogen to carbon ratio than fuel oil and produces less CO2 per unit of energy (L. Kirk, et al., 2014). CNG has a lower price than fuel oil, higher octane content, exhaust emissions that are cleaner and environmentally friendly compared to fuel oil. (BS and Nature, 201. The development and utilization of natural gas in Indonesia are being intensified due to the mandate of Law No. 22 of 2001, natural gas itself is divided into 2 types, namely Compressed Natural Gas (CNG) in the process of compressing CH_4 methane extracted from natural gas and Liquid Petroleum Gas (LPG) which is dominated by propane C_3H_8, butane C_4H_{10} with hydrocarbon content. Other lighter examples are ethane C_2H_6 and pentane C_5H_{10}. Pressure Reducing Station is a device consisting of a heated pipe that is used as a pressure reducer, the gas which was originally pressurized 200 bar is changed by heating, so the pressure can be reduced to 2 bar which can then be used for industrial purposes. CNG heater or we can call this part with a heat

exchanger or gas meter. In this study the authors tested the Pressure Reducing Station tool to reduce the CNG cradle tube pressure from 200 to 2 bar in accordance with the assumptions of the calculation and design. Natural gas in Indonesia is classified as high, but the utilization of natural gas in Indonesia is still minimal, so further utilization is needed. Pressure reducing station is a tool that can reduce gas pressure from 200 bar to 2 bar, therefore researchers use a pressure reducing station for natural gas utilization and industrial stove usage from 200 bar to 2

2. **The corner stone of the theory**

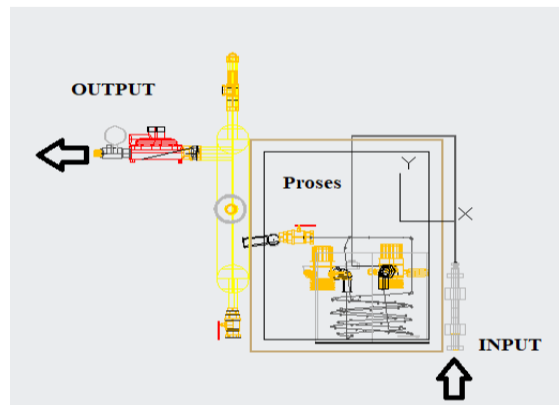### *2.1 The concept of work Pressure Reducing Station*

Fig. 1: the concept of work pressure reducing station

- Process input: using a hose interconector hose with jet tube cradle cng to male conector which is already installed in the panel box to ball valve high pressure in the process fluid flows from the tube hose → → → high pressure ball valve tubing → male connector tee → opening 2 fluid lines → entry to 2 scote universal regulator to lower the pressure is high to medium.Proses : Setelah fluida mengalir dari scote regulator universal → spiral tube for heat exchange → gas heating by water transfer → medium pressure ball valve 2.
- Output: After fluid passes through the ball valve → forwarded using the connector leading into header → fluid capacity gas header → in the header there is a valve and ball valve savety → next forward towards regulators medium to low pressure → connector towards the stove.
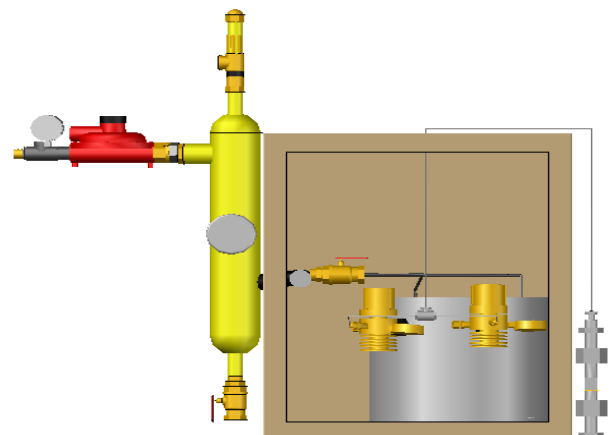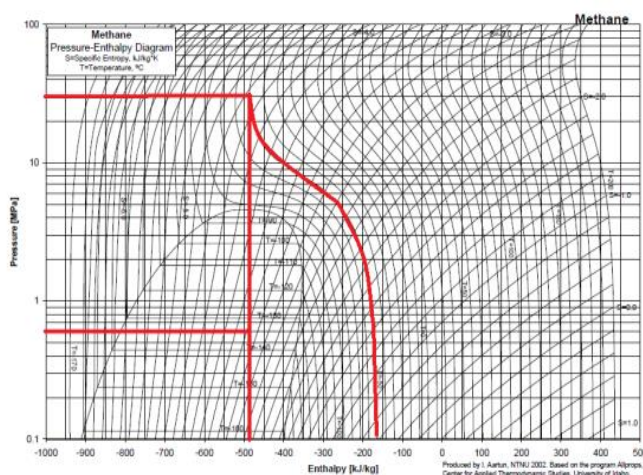

Fig. 2: Diagram p-h Methane

2.2 Natural gas

Natural gas is a natural resource with the third largest reserves in the world after coal and petroleum. Natural gas or gas often called Earth is material or material that consists of fossils and fossil formed in the form of gas. The main component in natural gas is methane (CH_4), which is the shortest chain hydrocarbon molecules and lightest. Natural gas also contains molecules of heavier hydrocarbons such as ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}), as well as gases containing sulfur (sulphur).

3. Research methodology

The purpose of this study is to find out:

- Working temperature of the water.
- Temperature of the gas in the tubing before passing through the heat exchanger.
- Temperature of the gas in the tubing after passing the heat exchanger.
- Gas temperature in the header.
- Final temperature of the gas in the regulator.
- Discharge of gas that comes out for 1 minute.
- Height of the fire

4. Discussion

4.1 Testing the maximum temperature of the water

The results of testing the maximum water temperature are 76.5 ℃ for 2 hours of testing. The test was carried out using a thermocouple test instrument calibrated with Arduino Uno. So after averaging, it gets 75.25 ℃. The test is done by heating water using 600 watts heating element immersed in water to give heat to be absorbed by pipe for reducing the pressure.

4.2 Testing the Temperature of the Gas in the Tubing Before passing the Heat Exchanger

Testing is done with the opening of the stove opening of 20%, 40%, 60%, 80%, 100% within 1 minute by using a thermocouple calibrated with Arduino Uno. Here is a table of the average results of testing the temperature of the gas in the tubing before passing through the heat exchange:

No	Pengujian	Rata-rata
1	Bukaan 20%	34℃
2	Bukaan 40%	34,25℃
3	Bukaan 60%	34,5℃
4	Bukaan 80%	34,75℃
5	Bukaan 100%	35℃

4.3 Testing the Gas Temperature in Tubing After Passing the Heat Exchanger

Testing is done with the opening of the stove opening of 20%, 40%, 60%, 80%, 100% within 1 minute by using a thermocouple calibrated with Arduino Uno. Here is a table of the average results of testing the temperature of the gas in the tubing before passing through the heat exchanger:

No	Pengujian	Rata-rata
1	Bukaan 20%	53,25°C
2	Bukaan 40%	53,5°C
3	Bukaan 60%	53,75°C
4	Bukaan 80%	54°C
5	Bukaan 100%	54,25°C

4.4 Gas Testing on the Header

Testing the temperature of the gas in the header is done within 1 minute, using a thermocouple test instrument calibrated with Arduino Uno. After obtaining data results as in the table above, it can be averaged to 36.5 ℃.

4.5 Testing the final gas temperature in the regulator

Testing the final gas temperature in the regulator is done within 1 minute, using a thermocouple test instrument calibrated with Arduino Uno. After obtaining data results in the table above, it can be averaged to 41.25 ℃.

4.6 Gas Discharge Testing

Bukaan	Debit gas yang keluar $m^3/menit$
20 %	13
40 %	16
60 %	19
80 %	21
100 %	24

This test aims to read flow of gas that comes out within 1 minute at the stove openings of 20%, 40%, 60%, 80%, 100%.

4.7 Fire Height Testing

Bukaan	Tinggi Api Cm
20 %	33 cm
40 %	39 cm
60 %	45 cm
80 %	51 cm
100 %	56 cm

This test aims to determine the height of fire that comes out within 1 minute at the stove openings of 20%, 40%, 60%, 80%, 100%.

5. Conclusion

After testing the pressure reducing station tools the results are as followed:

- Testing the maximum temperature of water in the heat exchanger results in 75.25 ℃

- The average results of testing the temperature of the gas in the tubing before passing the heat exchanger at each opening, averaging 34,2 degrees.

- The average gas temperature test in the tubing after passing the heat exchanger at each opening, averaging 53.5

- Gas temperature at the header is 36.5 ℃

- Gas temperature at the regulator is 41.25 ℃

- Discharge of gas that comes out at each opening, as follows:

    - Aperture of 20%   = 13 m^3/s
    - Aperture of 40%   = 16 m^3/s
    - Aperture of 60%   = 19 m^3/s
    - Aperture of 80%   = 21 m^3/s
    - Aperture of 100% = 24 m^3/s

- Fire height at each opening, as follows:

    - The aperture of 20%   = 33 cm
    - The aperture of 40%   = 39 cm
    - The aperture of 60%   = 45 cm
    - The aperture of 80%   = 51 cm
    - The aperture of 100% = 56 cm

These results show that pressure reducing station that being designed is suitable for small scale industry such as restaurants or catering, by having low to medium debit, low temperature operation and sufficient flame length.

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